World Journal of Pharmaceutical Science and Research
www.wjpsronline.com
Review Article
ISSN: 2583-6579
SJIF Impact Factor: 5.111
Year - 2025
Volume: 4; Issue: 3
Page: 1389-1403

HOLISTIC PERSPECTIVES ON PCOS: A REVIEW ON MEDICINAL PLANTS

Akula Sowjanya[1*], B. Deepika[2], J. Kavya[3], K. Poojitha[4], E. Mahima[5]

[1]Associate Professor, Department of Pharmacology, Marri Laxman Reddy Institute of Pharmacy, Dundigal, Hyderabad.
[2,3,4,5]Students of Marri Laxman Reddy Institute of Pharmacy, Dundigal, Hyderabad.

Article Received: 19 May 2025 // Article Revised: 08 June 2025 // Article Accepted: 30 June 2025

***Corresponding Author: Akula Sowjanya**
Associate Professor, Department of Pharmacology, Marri Laxman Reddy institute of Pharmacy, Dundigal, Hyderabad.
DOI: https://doi.org/10.5281/zenodo.15806264

How to cite this Article: Akula Sowjanya, B. Deepika, J. Kavya, K. Poojitha, E. Mahima (2025) HOLISTIC PERSPECTIVES ON PCOS: A REVIEW ON MEDICINAL PLANTS. World Journal of Pharmaceutical Science and Research, 4(3), 1389-1403. https://doi.org/10.5281/zenodo.15806264

ABSTRACT

Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder that affects 5-16% of women of reproductive age, leading to symptoms like irregular menstruation, anovulation, hyperandrogenism, and infertility. This review examines the pathophysiology, symptoms, and managing PCOS, based on data from sources like Science Direct, NIH, and Google Scholar. The disorder is multifactorial, influenced by genetic predisposition and environmental factors such as diet, stress, and exposure to environmental pollutants. Internal factors like insulin resistance, obesity, oxidative stress, and inflammation also contribute to its development. The pathophysiological mechanisms of PCOS involve disrupted hormonal signaling and altered follicular development. Management approaches focus on improving insulin sensitivity, regulating ovulation, and reducing hyperandrogenism. Lifestyle modifications, including dietary changes, exercise, and yoga, are considered first-line therapies, while hormonal treatments like metformin and clomiphene citrate are commonly prescribed. Additionally, medicinal plants such as Mangifera, cinnamon, and Vitex agnus-castus, etc. May help manage PCOS symptoms, though they should complement, not replace, conventional treatments. Methodologically, the review synthesizes findings from literature on PCOS pathogenesis and treatments and presents an integrated approach combining lifestyle changes, medications, and herbal remedies. Early diagnosis and holistic management are essential to improving fertility outcomes and overall health in women with PCOS. This review underscores the need for ongoing exploration of effective treatment, emphasizing personalized care approaches.

KEYWORDS: Estrous, Fertility, Genetic Predisposition, Polycystic Ovarian Disease, Polycystic Ovarian Syndrome.

INTRODUCTION

PCOS or polycystic ovarian syndrome is a prevalent endocrine condition that affects 5-16% of women who are of reproductive age. Anovulation, hyperandrogenism, and the characteristic ovarian shape, or polycystic ovaries (PCO), are the main symptoms of PCOS. It is frequently exacerbated by metabolic disorders like obesity and insulin resistance.[1] An Italian doctor named Vallisneria described an infertile married woman in the year 1721 who had pigeon-egg-sized, shining, white ovaries. Formal diagnosis criteria were not proposed or widely used until the early 1990s at a PCOS meeting sponsored by the National Institute of Health (INH), and they have since been widely used. Scientists have carried out a number of investigations and attempts to explain the pathophysiology of PCOS. Although it has been acknowledged that it is partially hereditary and multifactorial, several potential genes have been proposed. Insulin resistance is common in women with PCOS, particularly those with hyperandrogenism, but it is not a diagnostic criterion. Research indicates that PCOS individuals have higher levels of cardiovascular disease risk factors and glucose metabolism abnormalities than the general population.[2] International evidence found that the prevalence of PCOS could be as high as 26% among some population, though ranges between 4% and 18% are reported for general populations. As per World Health Organization (WHO), PCOS affects over 8-13% of reproductive-aged women.[3]

In addition to genetic factors, epigenetic changes in fetal life, lifestyle, hormonal imbalances, and environmental factors may also contribute to the development and manifestation of PCOS.[4] PCOS can be characterized as an oligogenic disorder, with both hereditary and environmental factors playing a significant role in its onset.[5] Familial clustering suggests that genetic factors are important in the development of the syndrome.[4] Environmental contaminants, such as pesticides, heavy metals, and endocrine-disrupting chemicals (EDCs), are known to impact human reproduction and are linked to an increased risk of PCOS.[6] A combination of factors, including obesity, insulin resistance, excess androgen exposure, and hypothalamic and ovarian dysfunction, contributes to the multifactorial nature of the disorder.[7] Furthermore, lifestyle factors like poor diet, viral mediators, and environmental pollutants such as polycyclic aromatic hydrocarbons (PAHs) are also implicated in the development of PCOS.[8] Several herbal plants, including jeera powder (cumin seed powder), green tea, chia seeds, anise, fenugreek, evening primrose oil, turmeric, cinnamon powder, fennel seeds, and flax seeds, have been highly regarded for their benefits in lowering PCOS symptoms, as well as for their anti-obesity and hypoglycemic effects. Integrated therapies, such as yoga and traditional herbal remedies, have shown positive outcomes in managing PCOS since ancient times, offering a holistic approach to treatment.[9] This review is focused on the most current information related to PCOS, its underlying mechanisms, and the role of herbs and lifestyle modifications. It also examines the possibility of enhanced therapeutic outcomes through the combination of herbal treatments.

PCOD & PCOS

Polycystic Ovarian Disease (PCOD) is a condition caused by hormonal imbalances, leading to irregular periods, excess hair growth, weight gain, and fertility issues. It involves small cysts on the ovaries and high levels of male hormones. These imbalances can cause PCOD to progress into PCOS.

Polycystic Ovary Syndrome (PCOS) is a metabolic condition characterized by the presence of multiple small cysts on either one or both the ovaries, hormonal imbalances, a range of symptoms such as elevated androgen levels, Menstrual irregularities. Unlike a single disease, PCOS is considered a syndrome, meaning it encompasses a group of symptoms that occur together, often associated with reproductive and metabolic health issues.[10]

PATHOPHYSIOLOGY

The pathogenesis of PCOS includes innate ovarian dysfunction that is heavily impacted by extrinsic variables, including hyperinsulinemia and hypothalamic-pituitary-ovarian axis disruptions. Hypersecretion of luteinizing hormone (LH) is caused by excessive gonadotropin-releasing hormone pulsatility, and this affects oocyte development as well as ovarian androgen production. The gonadotropin anomalies are accentuated by aberrant ovarian-pituitary and hypothalamic feedback. Both peripheral insulin resistance and aberrant beta cell activity in the pancreas are secondary causes of hyperinsulinemia. PCOS is inherited, and several genetic anomalies seem to contribute to the syndrome's characteristics and explain its symptom diversity. Environmental factors including diet and lifestyle also affect how the illness manifest.

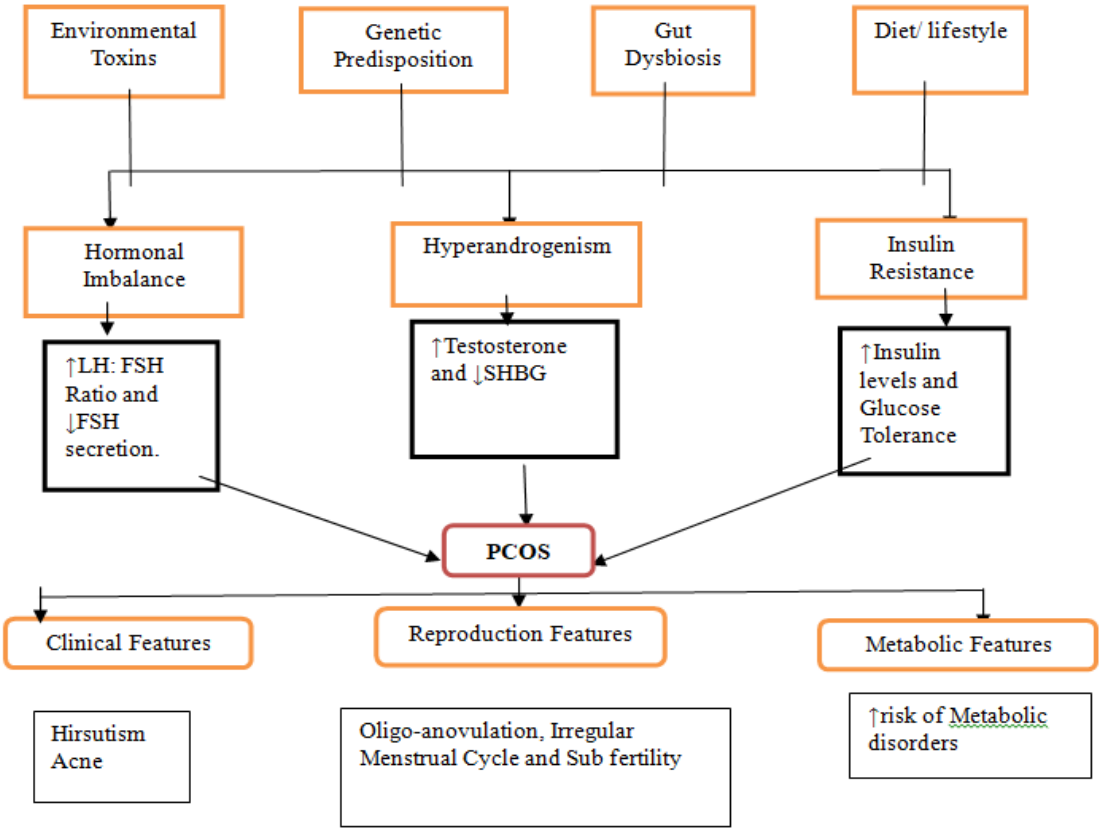

Figure 1: Illustrates the key molecular processes involved in the development of PCOS.

SYMPTOMS

Each person may experience polycystic ovarian syndrome symptoms differently. Oligomenorrhea, Amenorrhea, Prolonged erratic menstrual bleeding, Anovulation, Weight gain, Hirsutism, Fatigue, Thinning hair on head, Infertility, Acne, Mood changes, Pelvic pain, Sleep problems. [11]

ESTRUS CYCLE[12]

The primary reproductive cycle of other species is the estrous cycle, which is present in female non-primate vertebrates such as rats, mice, and others. The periodic pattern of ovarian activity in female mammals that enables them to transition from a time of reproductive receptivity to non-receptivity is known as the estrous cycle. Understanding and accounting for the estrous cycle is critical in various fields of research, including neuroscience, endocrinology, pharmacology, and behavioral science. Below are key aspects of its role in research.

Hormonal Influence: The estrous cycle is driven by fluctuations in hormones such as estrogen, progesterone, luteinizing hormone (LH), and follicle-stimulating hormone (FSH). These hormones influence a range of physiological and behavioral processes, making the estrous cycle an essential consideration when studying hormone-sensitive systems.

Behavioral Studies: Female behavior, such as mating receptivity, aggression, and locomotor activity, can vary significantly across different phases of the estrous cycle. In studies involving animal behavior, understanding the cycle helps distinguish behavior driven by experimental conditions from behavior driven by hormonal changes.

Biomedical Research: The estrous cycle can affect drug metabolism and efficacy, making it crucial for pharmacological research to consider these phases to understand sex-specific responses to medications. It also plays a role in pain sensitivity, immune responses, and susceptibility to certain diseases, which may fluctuate across the cycle.

Neuroscience: Hormonal changes during the estrous cycle influence brain function, including cognition, mood, and neuroplasticity. Studies investigating sex differences in brain function or the effects of neuroactive drugs often account for the estrous phase to avoid confounding results.

Reproductive Biology: The estrous cycle is central to understanding fertility, ovulation, and reproductive health in animal models. Research into conditions such as polycystic ovary syndrome (PCOS) or hormonal contraception relies on detailed knowledge of the estrous cycle.

- The estrous cycle comprising four distinct phases:

1. Proestrus (pre-ovulation)
2. Estrus (ovulation)
3. Metestrus (post-ovulation)
4. Diestrus (pre-menstruation).

1. Proestrus

- **Duration**: 12 to 14 hours
- **Hormones**: Estrogen levels rise as ovarian follicles grow.
- **Physiological Changes**: The ovaries prepare for ovulation. The peak of estrogen stimulates ovarian follicle maturation. The female becomes sexually receptive, ready for estrus.
- **Vaginal Cytology**: Nucleated epithelial cells are commonly seen in vaginal smears.

2. Estrus

- **Duration**: 12 to 24 hours
- **Hormones**: Ovulation occurs due to a surge in estrogen levels.
- **Physiological Changes**: The female is at the peak of sexual receptivity and fertility. Mating behaviours, such as arched back position (lordosis), are evident due to the high estrogen levels.
- **Vaginal Cytology**: Squamous epithelial cells that have cornified (keratinized) are seen in vaginal smears.

3. Metestrus

- **Duration**: 1 to 2 days
- **Hormones**: After ovulation, progesterone levels rise as the corpus luteum forms, and estrogen levels decrease.
- **Physiological Changes**: Sexual receptivity ends, and the female is no longer sexually active. The uterus starts preparing for possible pregnancy, and progesterone supports implantation.
- **Vaginal Cytology**: A combination of leukocytes and cornified cells are visible in vaginal smears.

4. Diestrus

- **Duration**: 2 to 3 days
- **Hormones**: Progesterone remains high while estrogen levels are low.
- **Physiological Changes**: The female is not sexually receptive. The body prepares for the next estrous cycle if fertilization does not occur, and the uterus remains quiescent.
- **Vaginal Cytology**: Leukocytes and a few small nucleated epithelial cells are typically seen in vaginal smear.

GENETIC INFLUENCE IN PCOS HORMONES [13][14]

Polycystic Ovary Syndrome (PCOS) is influenced by several hormonal and genetic factors. Insulin plays a crucial role, with the Insulin Receptor Substrate 1 (IRS1) gene being associated with insulin resistance. This resistance leads to hyperinsulinemia, worsening ovarian dysfunction and hyperandrogenism, common traits in PCOS. Androgens, regulated by the Cytochrome P450 17A1 (CYP17A1) gene, contribute significantly to the condition. Variations in this gene result in increased androgen production, leading to hyperandrogenism, a hallmark of PCOS that manifests as acne, excessive hair growth, and infertility.

Estrogen levels are regulated by the Estrogen Receptor 1 (ESR1), Estrogen Receptor 2 (ESR2), and Sex Hormone-Binding Globulin (SHBG). Imbalances in these components lead to irregular menstruation and anovulation, contributing to the development of PCOS. Progesterone, governed by the Progesterone Receptor (PGR) gene, is also vital. Low levels of progesterone, caused by lack of ovulation, result in irregular menstrual cycles, pregnancy complications, and the formation of ovarian cysts.

Lastly, gonadotropins such as luteinizing hormone and follicle-stimulating hormone, influenced by the LHCGR (Luteinizing Hormone/Choriogonadotropin Receptor) gene, also play a role. Irregular secretion of these hormones exacerbates menstrual irregularities and contributes to the progression of PCOS. These hormonal and genetic mechanisms collectively impact the reproductive and metabolic health of women with PCOS.

Table 1: IRS1 (Insulin Receptor Substrate 1), CYP17A1 (Cytochrome P450 17A1), ESR1 (Estrogen Receptor 1), ESR2 (Estrogen Receptor 2), SHBG (Sex Hormone-Binding Globulin), PGR(Progesterone Receptor), CG (Choriogonadotropin Receptor Gene).

S. No	Hormones	Associated Genes	Targeted Sites	Implied Mechanism	Gene Function	Relation With PCOS
1.	Insulin	IRS1[insulinsubstrate1] gene	Ovaries, Hypothalamus pituitary system.	Insulin resistance leads to compensatory hyperinsulinemia, worsening ovarian dysfunction and hyperandrogenism.	Regulates insulin action in cells, directly stimulates LH secretion	PCOS is often associated with insulin resistance. which leading to the improper reproductive function.
2.	Androgens	Androgen receptor gene	Adipose tissue, ovaries, skin (hirsutism, acne)	CYP17A1 genetic variations cause increased androgen production in the ovaries, leading to hyperandrogenism, a hallmark of PCOS.	Regulating ovarian granulosa cell also uterine growth due to androgen.	Women with PCOS have higher levels of the androgens. High levels of androgens will cause acne, excessive hair, infertility.
3.	Estrogen	ESR1 and ESR2 genes are associated.	Bone, breast tissue, uterus	SHBG controls Estrogen bioavailability, while CYP19A1 affects ovarian estrogen production. Imbalanced estrogen levels cause anovulation and irregular menstruation.	Mutations in the estrogen receptor genes, Development of PCOS.	A hormone imbalance that effects the reproductive health of the women abnormal function of estrogen leads to PCOS.
4.	Progesterone	PGR (Progesterone Receptor Gene)	Breast, uterine tissue	Lack of ovulation leads to low or absent progesterone, causing irregular menstruation and endometrial.	Menstrual cycle, and pregnancy and also fumction in PCOS. Ovulation , Implantation,	High levels of progesterone leads to the cysts in ovaries, Adrenal gland problems and menstrual irregularities, leads to PCOS.
5.	Gonadotropins	Luteinizing hormone/choriogonadotropin (LHCGR) gene.	Ovaries	Lack of ovulation leads to low or absent progesterone, causing irregular menstruation and endometrial	To make to secrete the hormones like Luteinizing hormone, and follicle stimulating hormone.	If the improper secretion of gonadotropins particularly the higher levels of the lutenizing hormone will be cause the PCOS.

TREATMENT

- Although PCOS cannot be cured, there are therapies that can improve symptoms**.**
- PCOS-related infertility can be treated with medication, surgery, or lifestyle modifications that promote regular ovulation.
- Although it can be used, in-vitro fertilization (IVF) carries considerable dangers.

1. **Life style modifications**

- Diet
- Exercise

2. **Hormonal treatment**

- Birth control pills (loestrin 24 Fe, Seasonale)

3. **Medications:(table 2)**

- Metformin
- Clomiphene citrate
- Leuprolide acetate
- Spironolactone
- Ethinyl oestradiol

Table 2: Commonly used medication in PCOS.

S. No	Drug With Class	Mechanism of Action	Drug Interactions	Side Effects	Uses
1.	Metformin-Biguanides class	It improves the insulin sensitivity in the liver & muscle tissues.	Renal dysfunction and Corticosteroid may counteract the effects of metformin.	Gastrointestinal distress, lactic acidosis, altered gut microbiota.	Reduce the androgen production, restores the regular ovulation.
2.	Clomiphene citrate-Ovulatory stimulants class	Binds to the oestrogen receptor in hypothalamus & reduces the negative feedback of the oestrogen in the hypothalamic pituitary-gonadal axis. And increases the FSH & LH secretions by increasing the follicular development and ovulation.	Concurrent use of other oestrogenic drugs may reduce the efficacy of clomiphene.	Ovarian hyper stimulation syndrome, Endometrial alterations, Multiple follicular development.	Induce ovulation.
3.	Leuprolide acetate-Gonadotropin releasing hormone agonist class	Initially stimulate the release of FSH & LH but with continuous administration they may leads to down regulations of GnRH receptors and reduces the gonadotropin production & ovarian androgen levels.	Oestrogen therapy, corticosteroids.	Bone loss, menopausal symptoms & initial flair.	Reduces the gonadotropin production & androgen levels.
4.	Spironolactone-antiandrogen drug class	Binds to ndrogen receptor antagonists & blocks the effects the testosterone on the ovaries.	It interacts with various medications including ACE inhibitors, heparins, & NSAIDs, over the counter (OTC) drugs and also with alcohol, caffeine, & potassium supplements.	Hyperkalemia and Diuresis.	Reduces hyperandrogenism and controls the condition of hirsutism & acne.
5.	Ethinyl oestradiol-Oral contraceptives class	Suppresses the GnRH release that reduce the androgen production.	Anti-convulsions and antibiotics.	Endometrial changes and hormonal imbalances, metabolic effects.	Reduces follicular development and regulate ovarian functions.

4. Reported medicinal plants for the treatment of PCOS

Medicinal plants should be prioritized for treating PCOS due to their natural, hormone regulating properties that target the root causes of the condition, which can help alleviate symptoms with fewer side effects compared to pharmaceutical medications that have long-term side effects.

Table 3: HDL-Cholesterol (High-Density Lipoprotein Cholesterol), ELISA (Enzyme-Linked Immunosorbent Assay), LH (Luteinizing Hormone), FSH (Follicle-Stimulating Hormone), SOD (Superoxide Dismutase), MDA (Malondialdehyde) RIA (Radioimmunoassay), FBG (Fasting Blood Glucose), CRP (C-Reactive Protein), BUN (Blood Urea Nitrogen), IGF-1 (Insulin-Like Growth Factor 1), OGTT (Oral Glucose Tolerance Test), BMI (Body Mass Index), TSH (Thyroid-Stimulating Hormone), DHEA (dehydroepiandrosterone), TAC (Total Antioxidant Capacity).

S. No	Plant Name	Method of Induction	Biochemical Parameters	Conclusion
1	Vitex Agnus Castus (Chaste Tree) [15]	PCOS induced in rats using letrozole (1 mg/kg) for 21 days; treated with metformin, Vitex Agnus Castus plant extract for 15 days	Spectrophotometry for HDL-cholesterol, triglycerides, glucose, cholesterol; ELISA for estrogen, serum insulin, progesterone, LH, FSH, testosterone, catalase, SOD, MDA	Antioxidant, antihyperlipidemic, and antihyperglycemic properties; helpful in treating PCOS
2	Cryptanshinone (from Salvia miltiorrhiza)[16]	DHEA (6 mg/kg) injected subcutaneously into rats for 20 days	RIA for LH, FSH, cholesterol, triglycerides, fasted plasma glucose	Effects on hormonal and metabolic parameters; potential therapeutic for PCOS
3	Chamomile (Chamaemelum mobile) [17]	Estradiol valerate induced PCOS in virgin rats, treated with chamomile extract (25, 50, 75 mg/kg) for 30 days	ELISA for LH, FSH, estradiol	Anti-estrogenic and antioxidant properties; helps regulate menstrual cycles and endometrial tissue arrangement
4	Green Tea (Cammellia sinensis) [18]	Estradiol valerate induced PCOS in Wistar rats; treated with green tea extract (50, 100, 200 mg/kg) for 60 days	ELISA for FSH, LH, testosterone, insulin; glucose oxidase technique for blood glucose	Strong antioxidant, reduces insulin resistance, promotes weight loss, reduces cysts, improves reproductive and metabolic features
5	Ocimum Sanctum (Tulsi)[19]	Letrozole (1 mg/kg) induced PCOS in female Wistar rats; treated with 100, 200 mg/kg doses of extract for 15 days	ADVIA for testosterone, progesterone, estrogen; Trinder's method for FBG; serum lipid profile by enzymatic kits	Antioxidant, anti-inflammatory; promotes ovulation, increases fertility
6	Galega Officinalis (Goat's Rue)[20]	Estradiol valerate injected into rats, treated with different doses (200, 400 mg/kg) of G. officinalis extract for 2 weeks	ELISA for glucose, insulin, testosterone, estrogen, FSH, LH, aromatase	Antioxidant; decreases insulin resistance, prevents hyperandrogenism, decreases cystic follicles
7	Lepidium meyenii (Maca)[21]	Female Sprague-Dawley rats fed 5%, 25%, 50% maca powder for 7 weeks	ELISA for pituitary hormones	Triggers ovulation, increases fertility
8	Areca Catechu [22]	Female albino rats treated with Areca catechu ethanolic extract (100, 300 mg/kg) for 15 days	Cholesterol estimated by manual kit	Anti-ovulatory properties, regulates periods, manages PCOS
9	Asparagus Racemosus (Shatavari)[23]	Estradiol valerate induced PCOS in rats, treated with Asparagus or Metformin	Triglycerides, cholesterol, CRP, BUN, glucose, protein levels	Antioxidant; regulates menstrual cycle, promotes ovarian follicle development

10	Cinnamon (Dalchini)[24]	DHEA-induced PCOS in rats for 20 days, treated with cinnamon extract	ELISA for insulin, testosterone, IGF- 1, FSH, LH; blood glucose via OGTT	Anti-inflammatory, anti-obesity, anti-diabetic; supports metabolic function, recovers disturbed estrous cycle
11	Moringa Oleifera [25]	Metformin-treated PCOS rats given 500 mg of Moringa for hormone analysis	Glucose parameters, TNF-α, follicle count	Reduces insulin, glucose levels, TNF-α; improves follicle count
12	Aloe Vera [26]	Letrozole-induced PCOS rats treated with Aloe Vera gel for 30 days	Glucose sensitivity, cholesterol, hormone assay, antioxidant assay	Aloe Vera as adjunct therapy for PCOS; antioxidant-rich, improves hormonal balance
13	Licorice (Glycyrrhiza glabra) [27]	Letrozole-induced PCOS in rats for 4 weeks	Histological analysis, PCR, serum hormone analysis	Histological analysis, PCR, serum hormone analysis
14	Fenugreek (Trigonella foenum-graecum) [28]	Hydroalcoholic extract of Fenugreek with metformin for 4 weeks	Statistical analysis, BMI, FSH, LH, TSH, free testosterone	Improves ovulation and menstrual cyclicity in women with PCOS
15	Foeniculum vulgare (Fennel) [29]	Double-blinded study with fennel extract for 4 weeks	Ultrasonography, statistical analysis	Fennel not effective in alleviating ovarian cyst symptoms in PCOS
16	Caffeine[30]	Estradiol valerate induced PCOS in rats, treated with caffeine	Histological analysis, ovarian volume, gene expression	Reduces apoptosis and inflammation, improves symptoms of PCOS
17	Tribulus Terrestris[31]	Letrozole-induced PCOS in rats for 21 days	Serum hormone assay for testosterone, insulin, OGTT	Improves insulin sensitivity, reduces body fat, restores hormonal balance
18	Pimpinella Anisum[32]	Estradiol valerate-induced PCOS, treated with Pimpinella	Vaginal smears, gonadotropin levels, histopathology	Improves metabolic dysfunctions in PCOS mice, including insulin resistance and fat accumulation
19	Mangifera Indica[33]	DHEA-induced PCOS in rats, treated with Mangifera	Statistical analysis, glucose, insulin, inflammatory cytokines	Improves ovarian function, reduces insulin resistance, Inhibits inflammation in PCOS
20	Mentha Piperita (Peppermint) [34]	Letrozole-induced PCOS in rats for 21 days	ELISA for FSH, LH, E2, T by RIA	Antioxidant properties, reduces androgen levels, prevents ovarian dysfunction
21	Symplocos Racemosa [35]	Letrozole-induced PCOS in rats for 21 days	Hormonal assays for testosterone, estrogen, progesterone	Anti-androgenic, improves hormonal balance, ovarian health
22	Pomegranate Juice Extract [36]	Estradiol valerate- induced PCOS	Hormonal assays for testosterone, estradiol, androstandion	Contains phenolic compounds, reduces testosterone, improves female sex hormones
23	Fagonia Indica [37]	Letrozole-induced PCOS for 21 days	Phenolic content (HPLC), ovarian cycle monitoring, hormonal assays	Reduces testosterone, increases estrogen and progesterone, improves ovarian histology
24	Turmeric Extract[38]	Letrozole-induced PCOS for 21 days	Hormonal assays, lipid peroxidation levels (MDA)	Antioxidant properties, improves fertility, maintains hormone levels
25	Palm Pollen [39]	Estradiol valerate-induced PCOS, treated with palm pollen extract	Hormonal assays for FSH, LH, progesterone	Reduces oxidative stress, normalizes ovarian function, increases hormone levels
26	Tephrosia	Letrozole-induced	Hormonal assays	Restores estrous cycle,

	Purpurea [40]	PCOS, treated with Tephrosia for 28 days	for testosterone, FSH, LH	decreases testosterone, improves ovarian health
27	Hawthorn Leaf Flavonoids [41]	DHEA-induced PCOS in rats	Serum glucose, insulin, estradiol, progesterone levels	Anti-inflammatory, improves estrous cycle, restores hormones, reduces cyst formation
28	Gymnema Sylvestre and Pergularia Daemia[42]	Estradiol valerate-induced PCOS, treated with Gymnema and Pergularia	Vaginal smears, estrous cycle assessment	Gymnema improves estrous cycle, Pergularia restores cycle, combination Improves menstrual irregularities
29	Lutein and Urtica Dioica (Nettle) [43]	DHEA-induced PCOS, treated with Lutein and Nettle	Hormonal assays, MDA and TAC levels	Nettle has anti-androgenic effects, Lutein improves antioxidant status, regulates hormones
30	Myrianthus Arboreus [44]	Wistar rats treated with Myrianthus extract for 30 days	ELISA for antioxidant enzyme activity, MDA, hormones	Balances hormones, reduces oxidative stress, improves ovarian function and fertility
31	Cocus Nucifera[45]	Ovariectomized rats treated with Cocus Nucifera extract for 7 days	Uterine weight, vaginal cornification	Estrogenic properties, mimics estrogen's effects on uterus, improves reproductive health
32	Flax Seeds [46]	Estradiol valerate-induced PCOS, treated with flaxseed extract for 30 days	Estradiol and progesterone levels	Improves ovarian health and hormone levels in PCOS rats
33	Zingiber Officinalis (Ginger) [47]	Estradiol valerate-induced PCOS in rats for 28 days	Hormonal assays (LH, FSH, Estradiol, Progesterone, Testosterone)	Anti-inflammatory, antioxidant, helps restore hormone balance and reduce cyst formation
34	Tinospora Cordifolia [48]	Oral doses of Metformin and Tinospora cordifolia extracts were given before DHEA-induced PCOS in mice.	Blood glucose, Hormonal balance (progesterone, estradiol, testosterone), Insulin sensitivity, Lipid profile	Tinospora cordifolia restores hormonal balance, improves insulin sensitivity, lowers cholesterol and triglycerides, and improves ovarian health.
35	Actaea Racemose [49]	1 mg/kg Letrozole for 21 days induced PCOS in female rats, followed by treatment with Actaea racemose extract and/or vitamin C.	Lipid profile, Liver enzyme changes	Anti-oxidant and Hormonal regulation properties. Improved reproductive and metabolic health in PCOS rats by regulating hormones, improving liver function, and reducing liver damage.
36	Cimicifuga Racemose [50]	Ovaries were cultured and treated with Dexamethasone (DEXA) to induce PCOS, followed by mtreatment with Cimicifuga racemose extract.	mRNA expression, Collagen fibers, Histology	Antioxidant and Anti-inflammatory properties Protects ovarian follicles from DEXA-induced damage suggesting potential benefits for long-term glucocorticoid therapy.
37	Panax ginseng (Red ginseng) [51]	Letrozole (1 mg/kg) induced PCOS in female rats for 21 days; treatment with Red Ginseng extract, alone or with ethinylestradiol (E) and levonorgestrel (L).	Testosterone, FSH, LH, Inflammatory markers	Anti-inflammatory and Anti-androgenic properties. Red Ginseng reduces PCOS symptoms, especially in combination with oral contraceptives.
38	Grifola Frondose [52]	Medroxyprogesterone acetate induced withdrawal bleeding; treatment with	FSH, LH, Testosterone	MSX promotes ovulation in PCOS and improves ovulation when combined

		Maitake mushroom extract (MSX) and Clomiphene citrate (CC) for ovulation induction.		with clomiphene citrate in non-responding patients.
39	Saraca asoca[53]	Letrozole (1 mg/kg) induced PCOS in female rats for 7 weeks; treatment with ethanolic extract of Saraca asoca.	FSH, LH, Progesterone, Testosterone, Insulin, Liver enzymes	Enhancing antioxidant activity and Insulin-regulating properties. The ethanolic extract (600 mg/kg) effectively manages PCOS by controlling weight, improving hormonal balance.
40	Bamboo (Bambusa bambos Druce) [54]	Letrozole induced 1 mg/kg for 21 days.	1. Determination of blood glucose levels. 2. Lipid profile. 3. Evaluation of reproductive system. 4. analysis	Anti-Oxidant activity. Bamboo shows promise as a novel agent for treating major metabolic symptoms of PCOS

CONCLUSION

In conclusion, polycystic ovarian syndrome (PCOS) is a complicated endocrine disorder characterized by both genetic and environmental factors including ovulatory dysfunction, hyperandrogenism, obesity and hormonal imbalances that contributes to the development of PCOS. Epigenetic influences and environmental pollutants are also increasingly recognized as contributing factors to PCOS. Each treatment approach targets different aspects of the condition, such as improving insulin sensitivity, restoring ovulation, and reducing hyperandrogenism, while there's no cure. PCOS can be managed with lifestyle changes, hormonal treatments and medications like metformin, clomiphene citrate, Leuprolide acetate, Spironolactone and Ethinyl oestradiol.

Medicinal plants have long been recognized for their therapeutic properties and benefits; they may help in managing the symptoms of PCOS. Medicinal plants can be beneficial, but they should support, not replace, established treatments and work alongside lifestyle changes as part of a holistic approach to health. Early diagnosis and management can help reduce symptoms and improve health and fertility.

REFERENCES

1. Kamada S, Yamamoto Y, Aoki H, Tamura K, Takeda A, Minato S, Masaki R, Yanagihara R, Hayashi N, Yano Y, Imaizumi J. A novel PCOS rat model and an evaluation of its reproductive, metabolic, and behavioral phenotypes. Reproductive medicine and biology, 2022 Jan; 21(1): e12416.
2. History of discovery of polycystic ovary syndrome. Adv Clin Exp Med, 2017 May-Jun; 26(3): 555-558. doi: 10.17219/acem/61987. PMID: 28791833.
3. https://www.who.int/news-room/fact-sheets/detail/polycystic-ovary-syndrome.
4. Tehrani FR, Noroozzadeh M, Zahediasl S, Piryaei A, Azizi F. Introducing a rat model of prenatal androgen-induced polycystic ovary syndrome in adulthood. Experimental physiology, 2014 May 1; 99(5): 792-801.
5. Ajmal N, Khan SZ, Shaikh R. Polycystic ovary syndrome (PCOS) and genetic predisposition: A review article. European journal of obstetrics & gynecology and reproductive biology: X, 2019 Jul 1; 3: 100060.
6. Singh S, Pal N, Shubham S, Sarma DK, Verma V, Marotta F, Kumar M. Polycystic Ovary Syndrome: Etiology, Current Management, and Future Therapeutics. J Clin Med, 2023 Feb 11; 12(4): 1454. doi: 10.3390/jcm12041454. PMID: 36835989; PMCID: PMC9964744.

7. Joham AE, Norman RJ, Stener-Victorin E, Legro RS, Franks S, Moran LJ, Boyle J, Teede HJ. Polycystic ovary syndrome. Lancet Diabetes Endocrinol, 2022 Sep; 10(9): 668-680. doi: 10.1016/S2213-8587(22)00163-2. Epub 2022 Aug 4. Erratum in: Lancet Diabetes Endocrinol, 2022 Nov; 10(11): e11. doi: 10.1016/S2213-8587(22)00281-9. PMID: 35934017.
8. Yang Q, Zhao Y, Qiu X, Zhang C, Li R, Qiao J. Association of serum levels of typical organic pollutants with polycystic ovary syndrome (PCOS): a case-control study. Hum Reprod, 2015 Aug; 30(8): 1964-73. doi: 10.1093/humrep/dev123. Epub 2015 Jun 3. PMID: 26040477.
9. Balkrishna A, Rana M, Mishra S, Srivastava D, Bhardwaj R, Singh S, Rajput SK, Arya V. Incredible combination of lifestyle modification and herbal remedies for polycystic ovarian syndrome management. Evidence-Based Complementary and Alternative Medicine, 2023; 2023(1): 3705508.
10. : Lakshmi, J.N.; Babu, A.N.; Kiran, S.S.M.; Nori, L.P.; Hassan, N.; Ashames, A.; Bhandare, R.R.; Shaik, A.B. Herbs as a Source for the Treatment of Polycystic Ovarian Syndrome: A Systematic Review. BioTech. 2023; 12: 4. https://doi.org/10.3390/ biotech12010004.
11. Bintey Zehra and Khursheed AA. Polycystic ovarian syndrome: Symptoms, treatment and diagnosis: A review. J Pharmacogn Phytochem 2018; 7(6): 875-880.
12. Ajayi AF, Akhigbe RE. Staging of the estrous cycle and induction of estrus in experimental rodents: an update. Fertility research and practice, 2020 Dec; 6: 1-5.
13. Ajmal N, Khan SZ, Shaikh R. Polycystic ovary syndrome (PCOS) and genetic predisposition: A review article. Eur J Obstet Gynecol Reprod Biol X, 2019 Jun 8; 3: 100060. doi: 10.1016/j.eurox.2019.100060. PMID: 31403134; PMCID: PMC6687436.
14. N Xita, I Georgiou, A Tsatsoulis, The genetic basis of polycystic ovary syndrome, European Journal of Endocrinology, Dec 2002; 147(6): 717–725, https://doi.org/10.1530/eje.0.1470717
15. Hamza AH, AlBishri WM, Alfaris MH. Effect of Vitex agnus-castus plant extract on polycystic ovary syndrome complications in experimental rat model. Asian Pacific Journal of Reproduction, 2019 Mar 1; 8(2): 63-9.
16. Yu, Jin, Zhai, Dongxia, Hao, Li, Zhang, Danying, Bai, Lingling, Cai, Zailong, Yu, Chaoqin, Cryptotanshinone Reverses Reproductive and Metabolic Disturbances in PCOS Model Rats via Regulating the Expression of CYP17 and AR, Evidence-Based Complementary and Alternative Medicine, 2014; 670743: 10 pages, 2014. https://doi.org/10.1155/2014/670743.
17. Farideh ZZ, Bagher M, Ashraf A, Akram A, Kazem M. Effects of chamomile extract on biochemical and clinical parameters in a rat model of polycystic ovary syndrome. J Reprod Infertil, 2010 Oct; 11(3): 169-74. PMID: 23926485; PMCID: PMC3719301.
18. Ghafurniyan H, Azarnia M, Nabiuni M, Karimzadeh L. The Effect of Green Tea Extract on Reproductive Improvement in Estradiol Valerate-Induced Polycystic Ovarian Syndrome in Rat. Iran J Pharm Res, 2015 Fall; 14(4): 1215-33. PMID: 26664389; PMCID: PMC4673950.
19. Farhana A, Reddy TA, Bhavana K, Mutha S, Bakshi V. Assessment of Ocimum sanctum to normalize the estrous cycle in letrazole induced polycystic ovary syndrome in female Wistar rats. World J. Pharm. Res, 2018 May 31; 7(14): 907-19.
20. Abtahi-Eivari SH, Moghimian M, Soltani M, Shoorei H, Asghari R, Hajizadeh H, Shokoohi M, Alami S, Ghaderi FK. The effect of Galega officinalis on hormonal and metabolic profile in a rat model of polycystic ovary syndrome. International Journal of Womens Health and Reproduction Sciences, 2018; 6(3): 276-82.

21. Lepidium meyenii (Maca) enhances the serum levels of luteinising hormone in female rats .Author links open overlaypanelFumiaki Uchiyama [a b], Tamaki Jikyo [b], Ryosuke Takeda [b], Misato Ogata [b] https://doi.org/10.1016/j.jep.2013.11.058
22. Shrestha J, Shanbhag T, Shenoy S, Amuthan A, Prabhu K, Sharma S, Banerjee S, Kafle S. Antiovulatory and abortifacient effects of Areca catechu (betel nut) in female rats. Indian J Pharmacol, 2010 Oct; 42(5): 306-11. doi: 10.4103/0253-7613.70350. PMID: 21206624; PMCID: PMC2959215.
23. Vishnuvardhan, C., Pazhanivel, N., Rao, G.V.S. and Parthiban, M. ALLEVIATIVE EFFECT OF AQUEOUS EXTRACT OF ASPARAGUS RACEMOSUS ON THE HAEMATO-BIOCHEMICAL PARAMETERS OF EXPERIMENTALLY INDUCED POLYCYSTIC OVARIAN SYNDROME IN WISTAR RATS. Indian Journal of Veterinary and Animal Sciences Research, 2022; 51(6): pp.39-45.
24. Dou, L., Zheng, Y., Li, L. et al. The effect of cinnamon on polycystic ovary syndrome in a mouse model. Reprod Biol Endocrinol2018; 16: 99 https://doi.org/10.1186/s12958-018-0418-y
25. Siahaan SCPT, Santoso B, Widjiati. Effectiveness of Moringa oleifera Leaves on TNF-α Expression, Insulin Levels, Glucose Levels and Follicle Count in Rattus norvegicus PCOS Model. Diabetes Metab Syndr Obes, 2022 Oct 26; 15: 3255-3270. doi: 10.2147/DMSO.S385492. PMID: 36304481; PMCID: PMC9595062.
26. Ghagane SC, Toragall MM, Akbar AA, Hiremath MB. Effect of Aloe vera (Barbadensis Mill) on Letrozole Induced Polycystic Ovarian Syndrome in Swiss Albino Mice. J Hum Reprod Sci, 2022 Apr-Jun; 15(2): 126-132. doi: 10.4103/jhrs.jhrs_22_22. Epub 2022 Jun 30. PMID: 35928465; PMCID: PMC9345283.
27. Yang H, Kim HJ, Pyun BJ, Lee HW. Licorice ethanol extract improves symptoms of polycytic ovary syndrome in Letrozole-induced female rats. Integr Med Res, 2018 Sep; 7(3): 264-270. doi: 10.1016/j.imr.2018.05.003. Epub 2018 May 30. PMID: 30271715; PMCID: PMC6160501.
28. Hassanzadeh Bashtian M, Emami SA, Mousavifar N, Esmaily HA, Mahmoudi M, Mohammad Poor AH. Evaluation of Fenugreek (Trigonella foenum-graceum L.), Effects Seeds Extract on Insulin Resistance in Women with Polycystic Ovarian Syndrome. Iran J Pharm Res, 2013 Spring; 12(2): 475-81. PMID: 24250624; PMCID: PMC3813238.
29. https://www.sciencedirect.com/science/article/abs/pii/S2210803319300235#:~:text=Results,number%20(p%20%3C%200.05).
30. Raoofi A, Rezaie MJ, Delbari A, Ghoreishi SA, Sichani PH, Maleki S, Nasiry D, Akhlaghi M, Ebrahimi V, Khaneghah AM. Therapeutic potentials of the caffeine in polycystic ovary syndrome in a rat model: Via modulation of proinflammatory cytokines and antioxidant activity. Allergol Immunopathol (Madr), 2022 Nov 1; 50(6): 137-146. doi: 10.15586/aei.v50i6.715. PMID: 36335457.
31. Parikha, Poonam Jayant Singh and Amitabh Krishna. “Anti-hyperglycaemic Activity of Tribulus terrestris Fruit Extract Restores Metabolic Imbalance in Letrozole Induced -PCOS Mice.” (2019).
32. abdul hussein mahood, Rasha. (2012). Effects of Pimpinella anisum oil Extract on Some Biochemical Parameters in Mice experimentally induced for human Polycystic Ovary Syndrome. Journal of Biotechnology Research Center. 6. 10.24126/jobrc.201
33. https://www.ajol.info/index.php/tjpr/issue/view/18818
34. Amoura M, Lotfy ZH, Neveen E, Khloud A. Potential effects of Mentha piperita (peppermint) on Letrozole-induced polycystic ovarian syndrome in female albino rat. International Journal, 2015; 3(10): 211-26.

35. Jadhav M, Menon S, Shailajan S. Anti-androgenic effect of Symplocos racemosa Roxb. against letrozole induced polycystic ovary using rat model. Journal of Coastal Life Medicine, 2013; 1(4): 309-14.
36. Hossein KJ, Leila KJ, koukhdan Ebrahim T, Nazanin SJ, Farzad P, Elham R. The effect of pomegranate juice extract on hormonal changes of female Wistar rats caused by polycystic ovarian syndrome. Biomedical and Pharmacology Journal, 2015 Dec 28; 8(2): 971-7.
37. Younas A, Hussain L, Shabbir A, Asif M, Hussain M, Manzoor F. Effects of fagonia indica on letrozole-induced polycystic ovarian syndrome (PCOS) in young adult female rats. Evidence-Based Complementary and Alternative Medicine, 2022; 2022(1): 1397060.
38. Shrivastava VK. Turmeric extract alleviates endocrine-metabolic disturbances in letrozole-induced PCOS by increasing adiponectin circulation: A comparison with Metformin. Metabolism open, 2022 Mar 1; 13: 100160.
39. Karimi Jashni H, Kargar Jahromi H, Bagheri Z. The effect of palm pollen extract on polycystic ovary syndrome (POS) in rats. Int J Med Res Health Sci. 2016; 5(5): 317-21.
40. Thakor AP, Patel AJ. Normalizing of estrous cycle in polycystic ovary syndrome (PCOS) induced rats with Tephrosia purpurea (Linn.) Pers. Journal of Applied and Natural Science, 2014 Jun 1 ;6(1): 197-201.
41. Yanhua Shi, Xiang Kong, Hongmei Yin, Wentong Zhang, Wei Wang; Effect of Hawthorn Leaf Flavonoids in Dehydroepiandrosterone-Induced Polycystic Ovary Syndrome in Rats. Pathobiology 6, June 2019; 86(2-3): 102–110. https://doi.org/10.1159/000493895.
42. Sudhakar P, Suganeswari M, Pushkalai PS, Haripriya S. Regulation of Estrous cycle using Combination of Gymnema sylvestre and Pergularia daemia in Estradiol Valerate induced PCOS rats. Asian Journal of Research in Pharmaceutical Science, 2018; 8(1): 4-8.
43. Bandariyan E, Mogheiseh A, Ahmadi A. The effect of lutein and Urtica dioica extract on in vitro production of embryo and oxidative status in polycystic ovary syndrome in a model of mice. BMC Complementary Medicine and Therapies, 2021 Dec; 21: 1-1.
44. Mvondo MA, Mzemdem Tsoplfack FI, Awounfack CF, Njamen D. The leaf aqueous extract of Myrianthus arboreus P. Beauv.(Cecropiaceae) improved letrozole-induced polycystic ovarian syndrome associated conditions and infertility in female Wistar rats. BMC Complementary Medicine and Therapies, 2020 Dec; 20: 1-3.
45. https://www.researchgate.net/publication/366723752_International_Journal_of_Innovations_in_Pharmaceutical_Sciences_INFLORESCENCE_OF_COCOS_NUCIFERA_LINN_IMPROVES_THE_TONE_OF_UTERUS_MUSCLES
46. Jelodar G, Masoomi S, Rahmanifar F. Hydroalcoholic extract of flaxseed improves polycystic ovary syndrome in a rat model. Iranian journal of basic medical sciences, 2018 Jun; 21(6): 645.,Pournaderi PS, Yaghmaei P, Hejazi SH, Noormohammadi Z, Khodaei HR. The effects of ginger extract on cyclooxygenase-2 gene expression in polycystic ovary syndrome rats. Journal of Basic Research in Medical Sciences, 2019 Sep 10; 6(4): 37-44.
47. Rani R, Chitme HR, Kukreti N, Pant P, Abdel-Wahab BA, Khateeb MM, Habeeb MS, Bakir MB. Regulation of Insulin Resistance, Lipid Profile and Glucose Metabolism Associated with Polycystic Ovary Syndrome by Tinospora cordifolia. Nutrients. 2023 May 9; 15(10): 2238. doi: 10.3390/nu15102238. PMID: 37242122; PMCID: PMC10221073.
48. Azouz AA, Ali SE, Abd-Elsalam RM, Emam SR, Galal MK, Elmosalamy SH, Alsherbiny MA, Hassan BB, Li CG, El Badawy SA. Modulation of steroidogenesis by Actaea racemosa and vitamin C combination, in letrozole

induced polycystic ovarian syndrome rat model: promising activity without the risk of hepatic adverse effect. Chin Med, 2021 Apr 29; 16(1): 36. doi: 10.1186/s13020-021-00444-z. PMID: 33926485; PMCID: PMC8086310.

49. de Assis EI, Azevedo VA, de Lima Neto MF, Costa FC, Paulino LR, Barroso PA, Matos MH, do Monte AP, Donato MA, Peixoto CA, Godinho AN. Extract of Cimicifuga racemosa (L.) Nutt protects ovarian follicle reserve of mice against in vitro deleterious effects of dexamethasone. Brazilian Journal of Medical and Biological Research, 2023 Sep 22; 56: e12811.
50. Moradi N, Bidgoli SA, Chaichian S. Ovarian cysts disappear after 14-day oral regimen of Korean red ginseng extract in letrozole-induced polycystic ovarian syndrome. Obstetrics & Gynecology Science, 2021 Mar 19; 64(3): 274-83.
51. Chen JT, Tominaga K, Sato Y, Anzai H, Matsuoka R. Maitake mushroom (Grifola frondosa) extract induces ovulation in patients with polycystic ovary syndrome: a possible monotherapy and a combination therapy after failure with first-line clomiphene citrate. The Journal of Alternative and Complementary Medicine, 2010 Dec 1; 16(12): 1295-9.
52. Bu N, Jamil A, Hussain L, Alshammari A, Albekairi TH, Alharbi M, Jamshed A, Bazmi RR, Younas A. Phytochemical-based study of ethanolic extract of saraca asoca in letrozole-induced polycystic ovarian syndrome in female adult rats. ACS omega, 2023 Nov 1; 8(45): 42586-97.
53. Soumya V, Muzib YI, Venkatesh P. A novel method of extraction of bamboo seed oil (Bambusa bambos Druce) and its promising effect on metabolic symptoms of experimentally induced polycystic ovarian disease. Indian J Pharmacol, 2016 Mar-Apr; 48(2): 162-7. doi: 10.4103/0253-7613.178833. PMID: 27127318; PMCID: PMC4825433.