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*Original Article*

# Herbal Harmony: Multi-Herb Strategies for Polycystic Ovary Syndrome (PCOS)

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## ABSTRACT

Pcos polycystic ovary syndrome is an complex endocrine disorder affect women reproductive age, Characterized by harmonal imbalance , metabolic disturbance, ovulatory dysfunction.Pcos occurs due to mental and emotional state .This review article focuses on shatavariherbal evaluation for pcos by using herbal excipients. Shatavari is recognised for its phytoestrogenic, adoptogenic , anti inflammatory and anti oxidant property which is use to regulate harmonal regulation , irregularities, oxidative stress . This review aim to overview dry powder extract from shatavari, fennel, Fenugreek, turmeric, stevia and various drugs. This combination provides treatment to balance pcos symptoms. It forms dynamic combo promising relief with minimal side effects.

**Keywords:** Harmonal imbalance , menstrual irregularities, pcos , antioxidative property

## INTRODUCTION

Today, farmers in India and other nations are learning a lot more about herb farming, and this trend will only continue to rise. Because of its minimal need for water and tillage methods, this plant is ideal for daily use. The polycytic ovarian syndrome, as the name implies, is a collection of symptoms that have been seen since ancient times. It is characterized by a range of indicators and symptoms associated with ovarian malfunction. It was initially referred to as "Stien-LeventhalSyndrome" by Stein and Leventhal in 1935. The incidence of PCOS Due to poor lifestyle choices and unhealthy eating practices, PCOS is now quite prevalent among women of reproductive age. Modern science treats PCOS with the last alternative is surgery (partial oopherectomy or drilling of the ovaries) and continuous usage of these, along with symptomatic therapy and hormone therapy. The use of drugs results in several side effects. Therefore, it is crucial to use herbal excipients to develop some efficient Ayurvedic therapies for this illness. Being women Since the root cause of offspring is the mother, utmost care should be taken to shield her from any illnesses that may impair her ability to be a mother. Polycystic ovarian syndrome (PCOS) is one such ailment. one of the circumstances influencing this specific ability of women. This illness is likely the most prevalent hormonal imbalance in women of reproductive age and Without a doubt, a major contributor to infertility. PCOS is the most prevalent endocrine illness in women between the ages of 18 and 44+, affecting around 10% of them. Between 5% and 10% of this age group is affected by it. It is a major contributor to infertility (infertility). Infrequent or absent menstruation is one of the clinical symptoms of PCOS. Symptoms of androgen excess (hyperandrogenism) include acne, seborrhea, and insulin resistance, as well as abdominal obesity. The long-term repercussions include an elevated risk of endometrial cancer, type 2 DM, dyslipidemia, etc. The etiology of PCOS is not well understood, but it arises when the ovaries are induced to release too much androgenic hormone. Particularly testosterone. Women with PCOS frequently have numerous tiny cysts on their ovaries that are discovered by ultrasound. Furthermore, there are several cysts on the ovaries that have been identified by ultrasound. Additionally, some `the presence of male hormones causes physical changes in women, such as hair loss on the scalp, facial hair growth, facial hair development, and other symptoms. acne and an accumulation of extra abdominal fat. The Onset of Type2 diabetes mellitus can be prevented if detected early and treated effectively with lifestyle changes. and the risk of coronary artery disease that results from it might be delayed or avoided. The causes of

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PCOS are still unknown. Recent evidence suggests that it may be linked to By directly affecting ovarian androgen secretion and aberrant follicular development, which results in insulin resistance, it has been demonstrated that insulin resistance plays a significant role in the etiology of PCOS. Using insulin-sensitizing medications and treating the malfunctioning ovary and menstruation caused by hyperinsulinemia is a successful strategy for treating PCOS. Although therapy can be beneficial in treating PCOS, prolonged use may have some adverse effects. Women with PCOS may benefit from alternative therapy. This is why current scientific research is focused on identifying the proven evidence from preclinical evaluation and summarizing the significance of herbs in treating these infertility issues. (2)

**Female reproductive system is as follows: -**

ovaries (outer cortex – follicles, inner medulla, blood vessels) are the source of gamete formations (ova)

**Hormonal production**: - estrogen, progesterone, etc

Ovulation is when fertilization and fetal development occur (during reproductive years) Sperm fertilization In uterus, embryo implantation ovaries are the primary reproductive organs Fallopian tubes, sometimes referred to as the oviduct or salpinges

**The body of the uterus**

- Cervix
- Fundus (top)
- Isthmus (lower segment)
- Layers (endometrium, myometrium, serosa
- Vagina: - connects cervix to vulva
- Vulva: - labia majora and minora Clitoris
- Meatus of the urethra
- The Vaginal opening
- Vulvar vestibule (uretheral and vaginal opening)
- Glands of Bartholin
- Menstrual cycle: - cyclical release of eggs from ovaries

**The term Polycystic ovarian syndrome refers to this condition: -**

- Attributes include persistent oligo/ anovulation.
- Polycystic ovaries (many immature follicles)
- Hormonal imbalance (androgens increased)
- Metablolic irregularities (insulin resistance, hyperinsulinemia)
- Mental problem

**Diagnostic issues include: - A** lack of consistent standards.

Infertility is the result.

**Treatment method includes: -** lifestyle changes, such as dietary adjustment (calorie and nutrient restriction).

Physical endeavors

Pharmacological treatment include: - metformin, thiazolidinediones, estrogen (progestin combinatios ) – oral contraseptives ,antiandrogens (flutamide , spironolactone )

Side effects: - weight gain, GI distress, erratic period, and greater insulin resistance are all adverse effect

**Herbal / medicinal plant approaches**: - long history of traditional use, growing modern research interest, supported by – case study, animal experiments, randomised controlled trials. (3)

## PATHOPHYSIOLOGY OF PCOS: -

The polycystic ovary is caused by functional derangement rather than a particular central or localized problem. However, a number of biochemical abnormalities have been identified, along with links between them. There are connections between them, and many of these disorders exacerbate one another in vicious cycles. Hyperandrogenism and anovulation, which are common with PCOS, might result from anomalies in four hormonally active areas.

* The hypothalamus-pituitary region
* The ovaries,
* The periphery,
* The adrenal glands (1)

The gonadotropic releasing harmone is either produced or secreted luiteinsing harmone (LH) and follicle stimulating harmone (FSH). A lesser quantity

of Normal follicular development depends on intraovarian androgen. FSH, which stimulates the aromatase enzyme, provides follicular development and encourages the granulose cell conversion of androgen. to estrogen. By promoting theca cell synthesis, LH initiates oocyte maturation. The LH level is elevated and the FSH level is lowered by the PCOS condition. results in the development of immature follicles, which lead to lower aromatase enzyme levels and increased androgen production. In PCOS, excessive androgens are linked to abdominal fat. Hyperinsulinemia and dyslipidemia are the results of that. Hyperinsulinemia also lowers the amount of sex harmone binding globulin (SHBG), which raises the concentration of circulating testosterone (4).

**Flow chart of pcos: -**

(Genes + family history)

⇩

(External triggers) unhealthy food, pollution stress, plastic like BPA

⇩

(Brain hormone imbalance) Brain release hormone pulses too fast – More LH, less FSH – hormone imbalance in ovaries

⇩

(Too much male hormones androgens)- facial hair, acne, hair thinning, irregular or no periods

⇩

(Eggs don't mature properly) – ovulation stops or becomes rare, ovaries develop many small cysts

⇩

(body stops responding to insulin) – insulin level go up (even without eating sugar)

⇩

(High insulin makes **PCOS**worse) – Boost male hormone production, lower good protein (SHBG) – more free testosterone

⇩

(weight gain + belly fat) – more inflammation in body, makes insulin resistance and hormone problems worse

⇩

(vicious cycle) – Hormones and insulin keep making each other worse

⇩

Perceptions – irregular periods, trouble getting pregnant, acne and hair issues, wt gain, mood swings, anxiety, high risk of diabetes. [5] [6] [7][8]

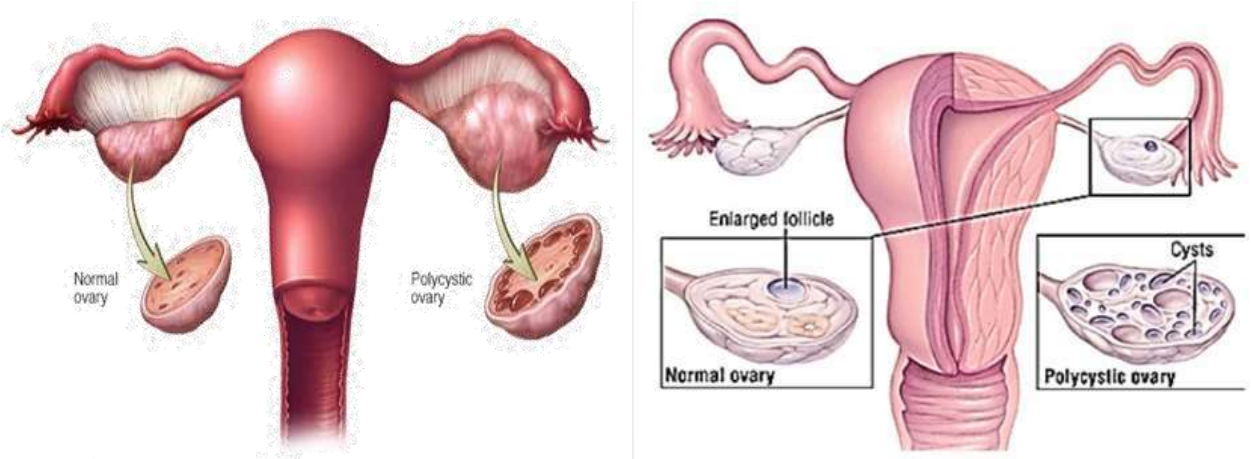


**FIG 1: Polycyst Ovary and Histological features of PCOS [19]**

**Histological Features of PCOS:**

Histological features of PCOS include:

- Whole ovarian hypertrophy
- Thickened capsule(>100µ)
- Increased number of subcapsular follicle cysts
- Scarcity of corporealuteaoralbicantia
- Hyperplasia and fibrosis of the ovarian stroma
- Premature luteinisation of theca cells. [20]

**Symptoms:**

- Absent periods
- Acne not associated with puberty
- Darkening of the skin
- Excessive hair growth
- Fatigue
- Fluid retention
- Heavy or prolonged periods
- Infertility
- Irregular periods
- Male pattern baldness
- Menstrual pain
- Mood swings
- Ovarian cysts
- Weight gain [19]

## PATHOPHYSIOLOGICAL MECHANISM: -

Organs involved in PCOS:

- Ovary- The female gonad organ present at either side of uterus.
- Adrenalgland- The gland which are placed just above the both the kidneys
- Pancreas-Glandthatproducesinsulin in our body.
- Pituitary Gland- The gland just below the brain, which is responsible forall the hormonal control. [19]

**Insulin resistance: -** Insulin resistance is a key feature of PCOS, contributing to hyperandrogenism and ovulatory dysfunction.

**Hyperandrogenism: -** Excess androgen production, primarily from the ovaries and adrenal glands, is a hallmark of PCOS.

**Inflammation: -** chronic low – grade inflammation is associated with PCOS, contributing to insulin resistance and metabolic complications.

**Adipose tissue dysfunctions: -** Adipose tissue plays a crucial role in PCOS pathophysiology, with impaired insulin singnaling and glucose transport contributing to metabolic disturbances. (9,10,11)

**Ovarian dysfunction: -**hyperandrogenism and IR disrupt ovarian function, leading to ovulatory dysfunction and polycystic ovaries.

**Gut microbiome: -** Alteration in the gut microbiome may play a role in PCOS pathogenesis, with some studies suggesting a link between a gut dysbiosis and metabolic and reproductive dysfunction.

**Endoplasmic reticulum stress: -**Follicular ER stress contributes to PCOS pathology by affecting granulosa cell function and promoting ovarian fibrosis. (12, 13, 14)

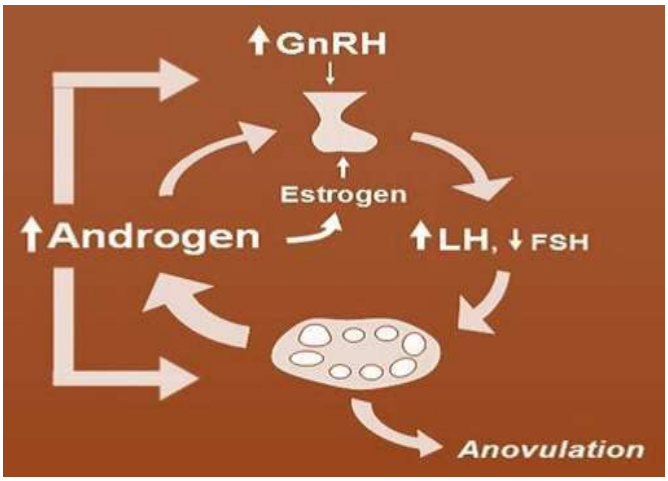


**Fig 2. Etiology of PCOS [19]**

**Causes of PCOS:**

- ✓ Genetic predisposition
- ✓ Strong stimulation in adrenal sinchildhood
- ✓ Raised insulin levels
- ✓ Contraceptive pills
- ✓ Hormonal imbalance
- ✓ Stress [19]

**Prevention and cure of PCOS: -**

Primarily focus on lifestyle and early screening to reduce risk factor.

**Life style modification (first – line prevention)**

- ➢ Healthy diet; high – fiber, high – protein, low glycemic index.
- ➢ Exercise: At least 60 min / day for adolescents moderate-to-vigorous activity.
- ➢ Weight control: Even a 5% wt loss can improve symptoms.
- ➢ Avoid wt gain during the puberty and adolescents.
- ➢ Stress reduction and sleep regulation.

**Early screening and monitoring:**

- ➢ Adolescents with irregular cycle and signs of hyperandrogenism should be closely monitored even if full criteria are not met.
- ➢ PCOS should be considered a lifelong condition so early detection can prevent complication like diabetes and cardiovascular disease.

**Education and empowerment:**

- ➢ Awareness about PCOS symptoms among adolescents and there care givers.
- ➢ Psychological support to manage body image issue and avoid wt stigma.

**Treatment for PCOS:**

- ✓ **Life style intervention:**

Remain the cornerstone treatment for all age groups. Helps manage obesity, insulin resistance, improves reproductive and metabolic health.

- ✓ **Medication:**

**(1) Metformin** – improve insulin sensitivity, reduce androgen levels, helps in wt loss.

**Side effect: -**Nausea, diarrhea, abdominal pain, vit b12 deficiency with long term use, not suitable for all ( eg – Those with kidney/ liver problem )

**(2) Letrozole (aromatase inhibitor):** first line for ovulation induction in women with infertility.

**Side effect: -** Hot flashes, fatigue, dizziness, nausea, potential for multiple pregnancy (twins, triplets)

**(3) Clomiphene citrate:** Previously comman ovulation induser now second line letrozole.

**Side effect: -** Lower pregnancy success compare to letrozole. High rate miscarriages and multiple pregnancies. Hot flashes, mood swings, ovarian hyperstimulation.

**(4) Gonadotropins:** use when oral drugs fail (second line infertility treatment)

**Side effect: -** High risk of ovarian hyperstimulation syndrome, multiple births more likely (twins/ triplets)

- ✓ **Hormonal therapies:**

**(1) Combinded oral contraceptive pills (COCPs) :** first line for manageing irregular cycle and hyper androgenism ( acne and hirsutism )

Low dose estrogen preferred: cyproterone actable only as second line due to clotting risk

**Side effect: -** Increased risk of blood clots, especially with cyproterone acetate. wt gain, mood change, nausea, cannot be used during pregnancy.

**(2) Progestins:** use cyclically for endometrial protection in non-menstruating womens.

**Side effect: -** Irregular bleeding, mood changes, bloating. Does not treat adrogenic symptoms (acne, hirsutism)

- ✓ **Anti-androgens (for cosmetic symptoms):**

Spironolactone, flutamide, finasteride: Helps to reduce hirsutism and acne but require contraction due to teratogenic risk.

**Side effect: -** Dizziness, menstrual irregularity, liver toxicity (especially Flutamide)

✓ **Inositol supplements:**

Myo-and D- chiro – inositol: Improve menstrual regularity and metabolic outcomes, though evidence modest.

**Side effect: -** OTC use without professional guidance can lead to inappropriate dosing.

✓ **GLP- 1 receptor agonists:**

(e.gLiraglutide ) usefull in PCOS patience with obesity and dibetes to assestwt loss and glycomic control .

**Side effect: -**Nausea, vomiting, pancreatitis risk.

✓ **Statins: For** lipid profile improvement and reducing cardiovascular risk in select patient

**Side effect: -** Muscle pain, liver enzyme, elevation.

✓ **Psychological and emotional support:**

Screening for depression, anxiety, eating disorders is essential in both adolescents and adults with PCOS. Beheaviour therapy and counselling recommended.

Side effect: - Mental health resources are not universily accessible. Eating disorders may be exacerbated by focus on weight management. [24] [25] [26]

Polyherbal formulation offer a promising approach for treating PCOS due to their multifaceted mechanism of action. Here's a breakdown of the rationale behinds using polyherbal formulation for PCOS.

**ADVANTAGES: -**

- Multi-target approach: Polyherbal formulations can target various pathways involved in PCOS, such as insulin resistance, hormonal imbalance, and inflammation, making them potentially more effective than single-herb treatments.
- Synergistic effects: Combining multiple herbs can enhance their individual benefits, leading to improved therapeutic outcomes.
- Reduced side effects: Polyherbal formulations may minimize side effects associated with conventional treatments, such as hormonal therapies. [15] [16] [17]

**Table 1: - From tradition to evidence: Exploring the efficacy and safety of Polyhedral formulation**

| Sr.no. | Therapy | Procedure |
|---|---|---|
| 1 | Ayurvedic therapy | Personalized treatment including herbal medicine, nutrition and lifestyle changes; considers PCOS symtoms under yonivyapad (eg- arajaska, lohitakshyav) |
| 2 | Tridosha therapy | Vatta- menstrual irregularities= treated with shatavari, satapushpa.<br>Pitta – Hirsutism, acne, CVD = manjishta, ashoka, neem, kutki.<br>Kapha- wt gain, cysts= Chandra prabha, shatavari, guggul. |
| 3 | Panchkarma | Vamana (Emesis)- Eliminates kapha for wt loss.<br>Virechana- remove pitta via liver and intestine.<br>Basti – rectal / uttarabasti for uterine cleansing.<br>Massage and fomentation – detox.<br>Nasya- Balance hormone via olfactory – GnRH pathway. |
| 4 | Aartavakshaya | Menstrual disease from vata / kapha imbalance; affect rasa and upadhatu .<br>PCOS is classified in Dosha , Dhatu and upadhatu involvement . |
| 5 | Natural ayurvedic cures | Herbs like licorice , aleovera , flaxseeds , cinnamon , tulsi , amla , fennel , pumkin seeds, curcumin are used to treat obesity , insulin resistance , cholesterol, hormone imbalance . |
| 6 | Unani therapy | Focus on metabolism and hormonal causes; ashwagandha, Tribulusterrestris used. lifestyle, diet, sleep, mental state are considered. |
| 7 | Sidha therapy | Menstrual regulation through vaatham , pitham , kapham. PCOS cause by kapha blocking vaatham / pitham . Treats amenorrhea dysmenorrhea, obesity, caused by energy imbalance. |

| | | |
|---|---|---|
| 8 | Homeopathic therapy | Treat route causes; 150+ remedies available. Personalised treatment base on constitution. egLycopodium – long cycle, right – sided pain, pulsatilla – irregular/ light menses, sepia- painful menstruation |
| 9 | Allopathic therapy | Symptomatic treatment with clomiphene citrate and metformine ; no complete cure available . |
| 10 | Surgical treatment | Ovarian drilling; for clomiphene – resistance cases, reduces androgens. Oophorectomy / Ovarian Wedge resection: Rare, considered in severe or non – fertility cases. |

**Table 2: - Polyherbal and natural remedies in PCOS: -**

| Sr. no | Drug name | Botanical name | Chemical constituent | Effects | Side effects |
|---|---|---|---|---|---|
| **1** | **Alovera**  | *Aloe Barba densis Miller*. (liliaceae.) | Aloin, emodin, aloesin , acemannan. | Normalizes estrogen and progesterone. Reduces ovarian cysts and restores menstruation. | At high dose may cause GI issues, Electrolyte imbalance, allergic reaction. |
| **2** | **Guggul**  | CommiphoraMukul. (Burseraceae) | Gugglsterone, myrrhanol, resin | Regulate thyroid function, balance estrogen and progesterone improve lipid profile. | Prolong use may leads to heavy menstrual bleeding, also drug interactions with birth control pills, hormonal therapies |
| **3** | **Turmeric**  | Curcuma longa (Zingiberaceae) | Curcumin, demethoxycurcumin, bisdemethoxycurcumine. | Anti-inflammatory , improve insulin resistance. | Nausea, diarrhea (at high dose). |
| **4** | **Flax seed**  | Linumusitatissimum(linaceae) | Ligans(Secoisolariciresinol), omega -3- fatty acids, mucilage. | Balance estrogen level, rich oin omega -3 fatty acid | Bloating, gas (high intake) |
| **5** | **Fennel**  | Foenicumvulgare (Apiaceae) | Anethole, Fenchome, estragole | Regulate menstrual cycle, phytoestrogenic effect | Allergic reaction, photosensitivity. |

| | | | | | |
|---|---|---|---|---|---|
| **6** | **Shatavari**  | Asparagus racemosus (Asparagaceae) | Saponins (shatavarins), flavonoids, alkaloids | Supports fertility and hormonal balance | Mild stomach upset, skin rash. |
| **7** | **Fenugreek**  | Trigonellafoenum-graecum. (Fabaceae) | Diosgenin, trigonelline, 4-hydroxyisoleucine | Improve insulin sensitivity, reduce testosterone, reduce cyst size. | Heavy bleeding, body odor, gas, hypoglycemic (if diabetic) |
| **8** | **Licorice**  | Glycyrrhizaglabra(Fabaceae) | Glycyrrhizin, liquiritin, glabridin | Lower testosterone and support estrogen, level anti-inflammatory. | High BP, low potassium (with long term use) |
| **9** | **Cinnamon**  | Cinnamomumverum/ c. Cassia (lauraceae) | Cinnamaldehyde, eugenol, coumarin | Lower blood sugar, improve insulin function | Liver toxicity at high use/ dose, allergic reaction |
| **10** | **Tulsi**  | Ocimum sanctum /o. Tenuiflorum (lamiaceae) | Eugenol, ursolic acid, rosmarinic acid | Anti-androgenic, reduces stress, regulates hormone. | Hypoglycemic, blood thinning (caution with anti-coagulants) |
| **11** | **Amla**  | Phyllanthusemblica (phyllanthaceae) | Ascorbic acid, Emblicanin A & B, Gallic acid. | Anti-oxidant, reducing insulin resistance | Diarrhea at high dose, May lower blood sugar too much. |
| **12** | **Sesame seed**  | Sesamunindicum (Pedaliaceae) | Sesamin, Sesamol, sesamolin | Regulate estrogen, anti-oxidant property. | Allergic reaction (rare) |

| | | | | | |
|---|---|---|---|---|---|
| **13** | **Pumpkin seed**  | Cucurbita pepo (Cucurbitaceae) | Cucurbitin, phytosterole, zinc, omega fatty acids | Rice in zinc, supports hormone production, anti-oxidant | Mild digestive upset (if over consumed) |
| **14** | **Myrrh**  | Commiphoram yrrha. (Burseraceae) | Furanoeudesma-1, 3-diene, lindestrene, sesquiterpenes. | Anti-inflammatory, helps in detox | Diarrhea, uterine bleeding, (avoid in pregnancy) |
| **15** | **Ashoka**  | Saracaasoca (Fabaceae) | Tannins, catechols, flavonoids | Supports uterine health,balance hormone. | Constipation, stomach discomfort. (rare) |
| **16** | **Gokhru**  | Tribulusterrestris (zygophyllaceae) | Protodioscin, saponin, alkaloids | Improve ovulation and fertility | Stomach upset, changes in mood or sleep(rare) |
| **17** | **Ginseng**  | Panax ginseng. (Araliaceae) | Ginsenosides (Rb1, Rg1, etc.), polysaccharides. | Enhance energy, regulates menstrual cycle. | Insomnia, nervousness, headache. |
| **18** | **Chamomoile**  | Matricaria Chamomilla (Asteraceae) | Apigenin, chamazulene, bisabolol | Reduce stress, supports hormonal balance. | Allergies (especially if allergic to daisies) Drowsiness. |
| **19** | **Ashwagandha** | Withania Somnifera (Solanaceae) | Withanolides, sitoindosides, alkaloids | Reduce cortisol, improve hormonal balance. | Drowsiness, upset stomach, thyroid stimulation (caution in hyperthyroid) |

| | | | | | |
|---|---|---|---|---|---|
| |  | | | | |
| **20** | **Moringa**<br>  | Moringaoleifera (moringaceae) | Quercetin, chlorogenic acid, isothiocyanates. | Rich in vit, minerals, reduces oxidative stress, may help insulin resistance | Nausea, diarrhea, uterine contraction (avoid in pregnancy) |

**Preparation method for polyherbalformulation use in treatment of PCOS: -**

**1. Standard procedure for polyherbal formulation: -**

➢ Selection of herbal ingredients based on its therapeutic roles in PCOS

- Anti- androgenic: Shatavari, licorice.
- Insulin – sensitizing: Fenugreek, cinnamon.
- Ovulation – inducing: Askoka, gokshura.
- Antioxidant/Anti-inflammatory: Amla, Guduchi.

➢ Authentication of raw materials with ensuring correct botanical identies

- Using microscopy / macroscopy evalution .
- TLC/ HPTLC finger printing.

➢ Cleaning of crude drug wash throughly to remove dust/ debries.

- Use distilled water and herbal washing standards.

➢ Drying

- Shade drying (40-50 degree Celsius)
- Avoid driect sunlight drying to preserve active phytoconstituents.

➢ Pulverization / grinding

- Use mechanical grinder to make uniform powder.

➢ Sieving

- Pass powder through sieve no 60-80 mesh and also ensure consistency in partical size.

➢ Blending of powder

- Use blender or ribbon mixer.

➢ Quality evalution of final powder

- Moisture content
- Ash value
- Microbial load
- Phytochemical screening.

➢ Sachet filling

- Fill the 3-5 gm dry powder in per sachet as use laminated pouches and label seal. [28]

❖ **Different ways to prepare sachet formulations include**:

Technique for making a powder formulation using extraction

- Herbal extraction – use solvents like alcohol and water to extract the active ingredient.
- Drying and concentration using vacuum and spray drying.
- Combining with excipients—diluting the dried extract with diluents like lactose, for example.
- Powder preparation - sieve and mix for consistency
- As is customary, fill the sachet.

- A technique based on granulation (dry granulation)

- Choose and pulverize herbs
- Combine with binders like gum acacia or starch.
- Roller compaction or slugging is used to create dry granulate
- Use a sieve to ensure a consistent granule size before filling the bag.

- The wet granulation technique

- Combine herbs with binder solution.
- Wet massing and granulation
- Drying the granules
- Blending and sieving
- Stuffing sachets

- Spread dry herbal preparation

- Herbal extraction using aqueous or alcoholic methods
- Concentration
- Spray drying with carriers
- Packing in sachets after sieving

- In the form of an encapsulated powder

- Obtain active components
- Cover with polymers
- Sift and dry
- Mix with carrier powder
- Filling the pouch [28] [29] [30]

**Table 3: - Evaluation parameters: -**

| Parameter | Description | Effect / importance |
|---|---|---|
| Adhesion and cohesion | Ability of particle to stick on surface. | Affects powder flow property and uniformity while handling. |
| Moisture content | Amount bound and unbound water present in powder. | Influence flowability and stability of formulation. |
| Particle size | Measured using sieving. | Determines flow properties (Fine- poor flow, coarse- good flow). |
| Particle shape | Observed as spherical, irregular, flakes, etc | Affects interparticulate contact area and flowability |
| Packing property | Arrangement of particles in bulk. | Influence flow and bulk density; tighter packing reduce flow. |
| Density | Bulk density and tapped density measurement | Determines compressibility, porosity. |
| Electrostatic charge | Charge develops during processing. | Alters powder flow property |
| Temperature effect | Changes during melting or freezing transition | Affect stability, reduce flow rate |
| Pressure | Compaction pressure applied | High pressure increase interparticle adhesion. |
| Angle of slide | Angle at which powder- laden plate begin to slide. | Indicates of flow (lower angle = better flow) |
| Bulk density | Weight of powder/bulk volume | Reflects particle arrangement in bulk. |
| Tapped density | Weight of powder/ tapped volume | Used to calculate compressibility. |
| Carr's index (CI%) | CI (%) =[(pt-pb)/pt] multiple by 100 | <15%= good flow,>25%= poor flow. |
| Hausner's ratio | Hr=pt/pd | <1.25= good flow,>1.6= very poor flow. |
| Reposography | Measures cone/spread of powders. | Assesses relative flow. |
| Vibrational capillary method | Powder flow measures vibration | Estimate mass flow rate. |

**Future approaches: -**

❖ Combination therapy with evidence – based herbs

- ❖ Personalized herbal medicines
- ❖ Nano formulation and modern delivery system
- ❖ Intergrative approaches with life style modification
- ❖ Clinical trials and standardization
- ❖ Targeting gut microbiota
- ❖ Green and sustainable herbal sourcing
- ❖ Digital health and AI intergration

Herbal and poly herbal formulation provides a promising strategy for PCOS management. They target multiple pathway including hormonal imbalance, insulin resistance, and inflammation. Those formulation may offers safe, effective and holistic treatment option for PCOS They harness the synergistic effects of multi herb to address the complex pathophysiology. Continued future research should validate efficacy through clinical trials these natural approach holds immense potential to improve lives of women living with PCOS globally.

## CONCLUSION: -

Herbal and poly herbal formulation provides a promising strategy for PCOS management. They target multiple pathway including hormonal imbalance, insulin resistance, and inflammation. Those formulation may offers safe, effective and holistic treatment option for PCOS They harness the synergistic effects of multi herb to address the complex pathophysiology. Continued future research should validate efficacy through clinical trials these natural approach holds immense potential to improve lives of women living with PCOS globally.

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