

## SELECTED INDIAN MEDICINAL PLANTS FOR MITIGATING POLYCYSTIC OVARIAN SYNDROME: A REVIEW

K. Shalini<sup>1</sup>, V. Chitra<sup>2</sup> and K. Ilango<sup>3,✉</sup>

<sup>1</sup>Department of Pharmacognosy, SRM College of Pharmacy,  
SRM Institute of Science and Technology, Kattankulathur-603203,  
Chengalpattu (Dt), Tamil Nadu, India.

<sup>2</sup>Department of Pharmacology, SRM College of Pharmacy,  
SRM Institute of Science and Technology, Kattankulathur-603203,  
Chengalpattu (Dt), Tamil Nadu, India.

<sup>3</sup>Department of Pharmaceutical Quality Assurance, SRM College of Pharmacy,  
SRM Institute of Science and Technology, Kattankulathur-603203,  
Chengalpattu (Dt), Tamil Nadu, India.

✉Corresponding Author: [ilangok1@srmist.edu.in](mailto:ilangok1@srmist.edu.in)

### ABSTRACT

The polycystic ovarian syndrome is one of the most frequent gynecological disorders among reproductive-age women (PCOS). The polycystic ovarian disease is also known as Stein Leventhal syndrome or high androgen anovulation syndrome. It is a common endocrine illness marked by polycystic ovaries, chronic anovulation, and hyperandrogenism, which causes irregular menstrual periods, hirsutism, acne, and infertility. It is linked with a high risk of hypertension, hyperlipidemia, and types 2 diabetes all of which can contribute to strokes and cardiovascular disease. It must be diagnosed early in order to avoid future health complications. Because it is a treatable condition, it can be treated with either natural or allopathic medicines. Treatment with phytoestrogenic and non-estrogenic herbs such as *Bauhinia variegata*, *Asparagus racemosus*, *Saraca asoca*, *Caesalpinia bonducella*, *Nigella sativa*, *Vitex negundo*, *Cinnamomum zeylanicum*, and *Symplocos racemosa* which are effective and safe, polyherbal formulation is obtained from medicinal plants. The role of herbal medicine in the treatment of PCOS is the topic of this review.

**Keywords:** PCOS, Anovulation, Infertility, Cardiovascular Disease, Phytoestrogenic

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### INTRODUCTION

Polycystic ovarian syndrome (PCOS) or polycystic ovary disease (PCOD) is a typical and heterogeneous disease that influences 5% to 10% of women of childbearing age. It is described by persistent anovulation with oligomenorrhea, raised luteinizing hormone (LH), obesity, chronic anovulation, augmented cystic ovaries and infertility, and hyperandrogenism. Insulin resistance is likewise a typical feature of the syndrome. The etiology of PCOS is still unidentified and the prevalence of this disease differs due to the alterations in genetic characteristics and living environment of its victims.<sup>1</sup> Clinical highlight of the syndrome may not manifest immediately or soon afterward menarche or might be misdiagnosed if they are viewed as typical discoveries of a pubertal turn of events. However, incidence rates as high as 26% have been observed, depending on the population investigated. Although the dispute over what constitutes PCOS continues, the most recent definition is the Rotterdam Statement on Diagnostic Criteria for PCOS, which was released in 2003. PCOS is diagnosed at least two of the following three criteria are met, polycystic ovaries on ultrasound examination, oligo-ovulation, or anovulation, clinical or biochemical confirmation of hyperandrogenism, and oligo-ovulation or anovulation (more than <sup>12</sup> small antral follicles in an ovary), along with a rejection of diseases like innate adrenal hyperplasia, androgen-emitting tumors, or Cushing's syndrome.<sup>2</sup> PCOS pathophysiology ordinarily incorporates overabundance of ovarian androgen production with a strange level of insulin resistance being a non-essential however regular aggravating variable. Hyperinsulinemia increases LH-stimulated androgen creation. The exact mechanism of follicular capture and anovulation is undefined yet it is realized that Anti-Mullerian Hormone (AMH) which is raised in

PCOS - assumes a prohibitive role in follicular growth. Women with PCOS often show signs of hyperandrogenism and the underlying etiology of PCOS is most likely complex. In addition to the weight record (BMI), increased insulin resistance is recognized as a major symptom of PCOS.<sup>3</sup> Clinical hyperandrogenism, with persistent skin inflammation, extreme hirsutism, as well as biochemical raised without serum or bioavailable testosterone level more prominent than 50 ng/dl, or raised luteinizing hormone/follicle-stimulating hormone ratio above 2, are the fundamental reasons that adolescents ask for clinical counsel, as restorative concerns may influence the self-perception, sexual personality, and other basic perspectives of their passionate and psychosomatic maturation. On the other hand, insulin resistance/hyperinsulinemia with acanthosis nigricans raised the weight list, and ensuring glucose intolerance is the primary worry for physicians.<sup>1</sup> Woman with PCOS can explore alternative treatments to address their infertility issues. As a result, the current scientific study concentrated on collecting preclinical evidence and assessing the significance of herbal treatments in polycystic ovarian syndrome. This review explained a botanical name, family, part used, chemical constituents, traditional uses, and other medicinal of selected medicinal plants for mitigating polycystic ovarian syndrome were mentioned in Table-1.

Table-1: List of Medicinal Plants

S. No.	Common Name	Botanical Name	Family	Part used	Chemical Constituents	Traditional Uses	Other Uses
1	Shatavari	<i>Asparagus racemosus</i>	Asparagaceae	Whole plant, root	Shatavarin I to IV, asparagin, Sarasapogenin, arginine, racemofuran	Refrigerant, demulcent, diuretic, aphrodisiac, antispasmodic, alternative tonic.	Versatile female tonic.
2	Kachnar	<i>Bauhinia variegata</i>	Caesalpiniaceae	Leaf, bark, heartwood	Apigenin-7-o-glucoside, apigenin, hesperidin, ascorbic acid, kaempferol	Alternative tonic, astringent, useful in skin diseases, dyspepsia, piles, diarrhea.	Prevent diabetic
3	Molucca bean	<i>Caesalpinia bonducella</i>	Caesalpiniaceae	Leaf, seed	$\alpha$ , $\beta$ , $\gamma$ , $\delta$ – caesalpin, lupeol, $\xi$ – caesalpin, bonducellin, caesalpinianone, 6-methyl caesalpinone.	Antiperiodic, antispasmodic, anthelmintic, febrifuge, intermittent fever.	Deobstruent and emmenagogue.
4	Asoca	<i>Saraca asoca</i>	Caesalpiniaceae	Bark, Flower	Quercetin, catechin, gallic acid, procyanidin B1, procyanidin B2.	Stomach ache, biliousness, dyspepsia, dysentery, colic, piles, ulcers and pimples.	Uterine affections
5	Five leaved chaste trees	<i>Vitex negundo</i>	Verbenaceae	Seed	Essential oil, triterpenes, diterpenes, sesquiterpenes, lignin,	Aromatic, tonic, vermifuge, relief headache,	Anti-PCOS

					flavonoids, agnuside, negundoside, negundin a, vitexicarpin, vitexin.	acute rheumatism, vermifuge.	
6	Black cumin	<i>Nigella sativa</i>	Ranunculaceae	Seed	Thymoquinone, p-cymene, thymol, limonene, citronellol.	Aromatic, carminative, stomachic, digestive, loss of appetite, fever, purpureal disease.	Emmenagogue.
7	Lodha	<i>Symplocos racemosa</i>	Symplocaceae	Bark	Ellagic acid, loturidine, betulinic acid, proanthocyanidins, linoleic acid.	Treatment of menorrhagia and uterine disorders, cooling, astringent, bowel complaints, eye diseases, ulcers.	Estrogenic activity improves gonadotropin release.
8	Cinnamon	<i>Cinnamomum zeylanicum</i>	Lauraceae	Bark	Cinnamic acid, cinnamaldehyde, cinnamyl alcohol, benzyl benzoate, coumarin, linalool, cinnamyl acetate, eugenyl acetate, procyanidin.	Aromatic, astringent, stimulant, carminative.	As a stimulant of the uterine muscular fiber, it is employed in menorrhagia.

### Herbal Medicine in Treatment of PCOS

#### *Asparagus Racemosus*

Shatavari signifies “who has a hundred husbands or acceptable to many”. It's considered a general tonic as well as a female reproductive tonic. Shatavari can be translated as "100 life partners," implying that it has the ability to increase fertility and vitality. In Ayurveda, this amazing spice is known as the “Queen of herbs” (Fig.-1), since it advances love and dedication.

Shatavari is the main ayurvedic rejuvenating tonic for women, while *Withania* is the key ayurvedic renewing tonic for men. *A. racemosus* (family Asparagaceae), also known as Shatavari, is a well-known Ayurvedic medication that is effective in the treatment of seetveeryam, Madhur vipakam, Madhur rasam, chronic fever, sonogram, and internal heat. In Indian medicine, it is well known as a demulcent, antispasmodic, diuretic, aphrodisiac, galactagogue, refrigerant, and nervine tonic. Diabetes, rheumatism, diarrhea, jaundice, urinary disorders, brain complaints, cough, blood illness, and bronchitis were all treated with it. Aerial parts of Shatavari are used as antibacterial, spasmolytic, anticancer, antibacterial, anti-fungal and antiarrhythmic.<sup>4</sup> *A. racemosus* is well-known for its phytoestrogenic properties. Interest in plant-derived estrogens has grown as it becomes clear that hormone replacement therapy with synthetic estrogens is neither as safe nor as

successful as previously thought, making *A. racemosus* particularly significant.<sup>5</sup> Phytochemical constituents Asparagus (Fig.-2) contains asparagine, tyrosine, bitter glycosides, quercetin, kaempferol, arginine, asparagosides, resin, shatavarins I and IV, sarasapogenin, racemofuran and racemoside A, B and C.<sup>6</sup>



Fig.-1: *Asparagus Racemosus*

The reported pharmacological activity of *A. racemosus* as antitussive effect, galactogogue effect, antiprotozoal activity, adaptogenic activity, antisecretory and antiulcer activity, antibacterial activity, gastrointestinal effects, antineoplastic, molluscicidal activity, antihepatotoxic, the effect on the uterus, cardiovascular effects, immunomodulatory activity, effect on the central nervous system, antioxidant effects, immunoadjuvant potential activity, teratogenic effects, antilithiatic effects, toxic effects, antidepressant activity, anti-inflammatory, aphrodisiac activity, diuretic activity, enhances memory and protects against amnesia, anti-stress activity, potential to prevent hepatocarcinogenesis, versatile female tonic, cytotoxicity, analgesic and antidiarrhoeal activities, reduced blood glucose and antirolithiatic activity.<sup>7</sup>

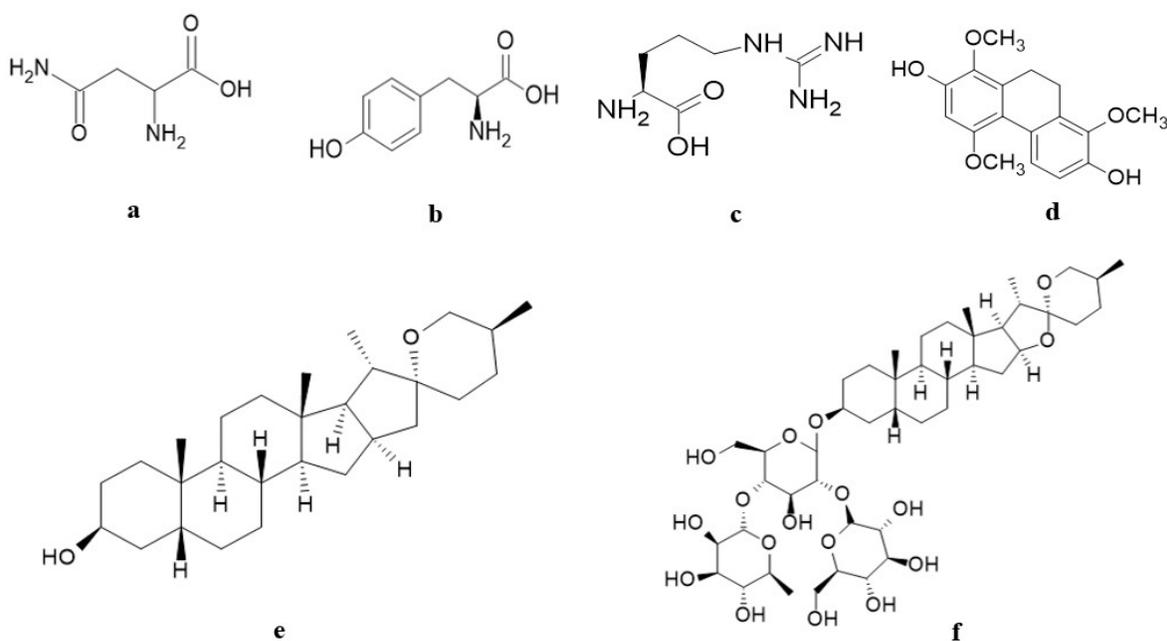


Fig.-2: Structure of (a) Asparagine (b) Tyrosine (c) Arginine (d) Racemosol (e) Sarasapogenin (f) Shatavarin - IV

***Bauhinia Variegata***

Mountain Ebony (English), Kachnar (Hindi), and Rakta Kanchan are all names for *Bauhinia variegata*, member of Caesalpinioideae or Leguminosae family (Marathi). It's a medium-sized deciduous plant that can be found all over India, usually at elevations of 1800 metres in the Himalayas. Around 600 species of shrubs, trees (Figure-3) and plants belong to the *Bauhinia* genus. Its primary function is that of an ornamental plant. It spreads across India and China.<sup>8</sup> Phytochemical constituents *B. variegata* contains (Fig.-4) 5,7 dihydroxy, kaempferol-3-glucoside, quercetin, beta-sitosterol, lupeol, hesperidin, tannins, vitamin C, fibers, crude protein, apigenin, reducing sugars, carbohydrates, amides, crude protein, apigenin-7-O-glucoside, heptatriacontane-12, 13-diol, calcium and dotetracontan-15-en-9-ol.<sup>9,10</sup> In traditional medicine, almost all parts are used to treat various ailments such as leprosy, asthma, ulcer, snake bite, liver complaints, and piles and its extracts have been found to have antibacterial and antifungal activity.

It is also used for dysentery, diarrhoea, fever, piles, skin disease, hemorrhoids, edema, wound healing, antidiabetic, immunomodulatory, antibacterial, antioxidant, nephroprotective, anti-cancer, skin diseases, dyspepsia, stomatitis, obesity and as a laxative tonic, astringent, anthelmintic, hepatoprotective agent, antileprotic, laxative, carminative and antitumor. *B. variegata* (alcoholic extract) dramatically lowers plasma glucose levels, triglycerides, cholesterol, blood urea nitrogen, and creatinine levels. The alcoholic extract didn't show any critical impact on plasma levels of aspartate aminotransferase, alanine transaminase, and alkaline phosphatase. This extract reduces necrotic alterations in pancreatic tissue, according to a histological examination. Extracts of *B. variegata* have been proven to be effective in the treatment of both type I and type II diabetes.<sup>11</sup>

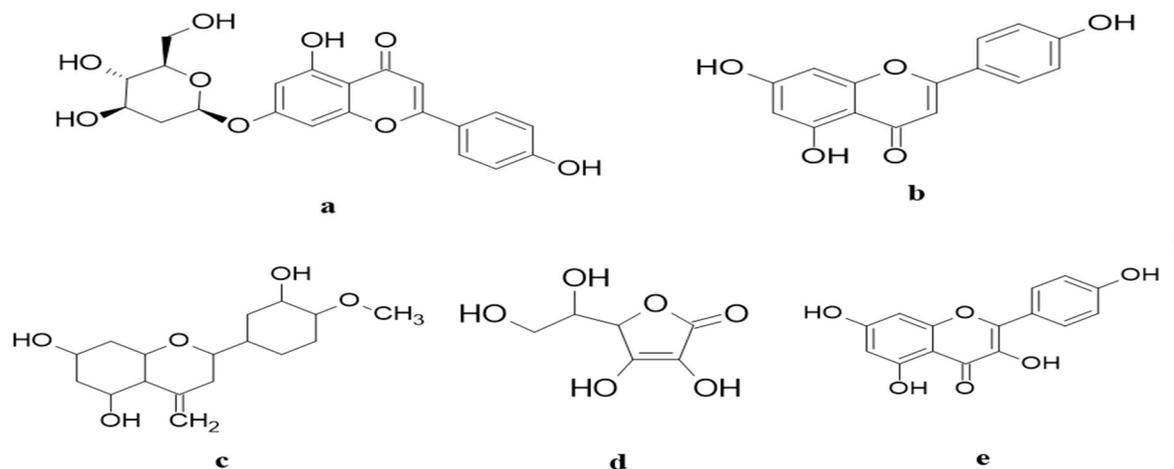
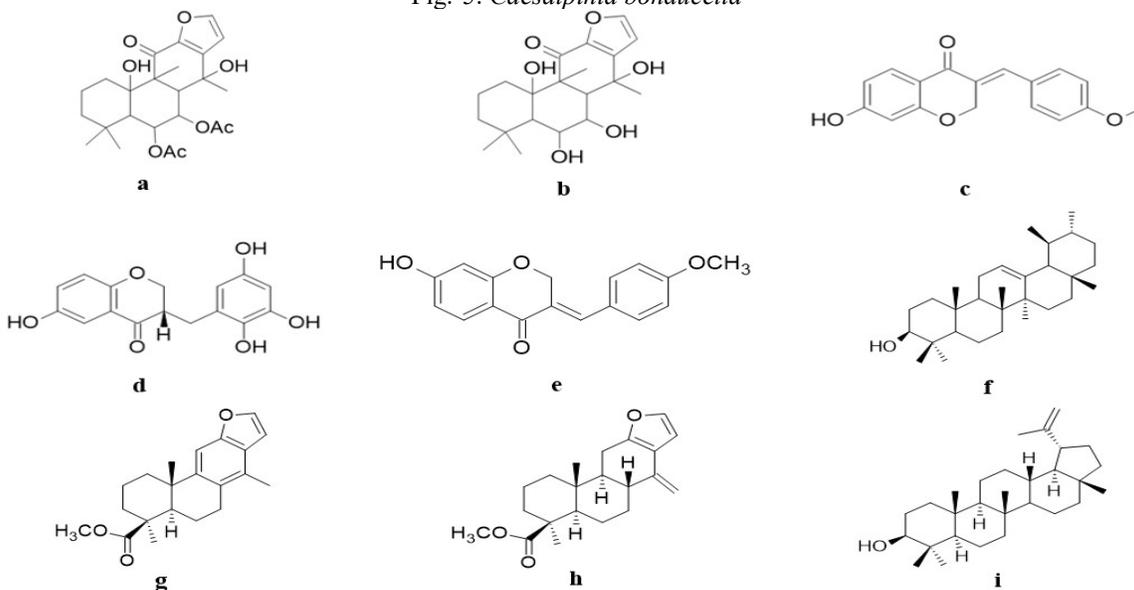
Fig.-3: *Bauhinia Variegata*

Fig.-4: Structure of (a) Apigenin-7-O-Glucoside (b) Apigenin (c) Hesperidin (d) Ascorbic Acid (e) Kaempferol

***Caesalpinia Bonducella***

*Caesalpinia bonducella* belongs to the Caesalpinaceae family. Usually, it is called Bonduc Nut, Fever Nut, and Nicker Nut also. Bark, nuts, seeds, leaves, stems, and roots are valuable as traditional medicine.<sup>12</sup> *C. bonducella* (Fig.-5) is a thorny shrub generally dispersed everywhere in the world. Phytochemical constituents of *C. bonducella* seeds contain (Figure-6)  $\alpha$ -caesalpin,  $\beta$ -caesalpin, g-caesalpin, a crystalline bitter compound, bonducellin, a homoisoflavone, and caesalpinianone caesalpin F-furanoditerpene.<sup>13</sup> It is a highly important therapeutic plant that is employed in the traditional medical system because different parts of the plant have therapeutic capabilities.<sup>14</sup> *C. bonducella* is accounted for to have different remedial properties like antidiuretic, antipyretic, antibacterial, anthelmintic, anti-diarrhoeal, anti-anaphylactic, antiviral, and anti-estrogenic, antipsoriatic activity<sup>15</sup>, anti-ulcer, anti-venom, anti-convulsants, anti-malaria, antipyretic, analgesic, antifilarial, antidiabetic<sup>16</sup>, adaptogenic, immunomodulatory, antiurolithiatic, antipsoriatic, and antiproliferative. In India, the seed of this plant is traditionally used to regulate female fertility. Parts of *C. bonducella*, as well as those of other species, are used as an emmenagogue and to help pregnant women deliver.<sup>17</sup>

Fig.-5: *Caesalpinia bonducella*Fig.-6: Structure of (a)  $\alpha$ -caesalpin, (b)  $\beta$ -caesalpin, (c) Boducellin, (d) Caesalpinianone (e) Isobonduceliline (f)  $\alpha$ - amyrin (g) Betaminine 1 (h) Betaminine 2 (i) Lupeol

***Saraca Asoca***

*Saraca asoca*, also known as *Saraca indica* (Fig.-7) and a member of the Caesalpiniaceae family, is a medium-sized evergreen tree native to India's humid regions. Asoka is regarded as a sacred tree by Hindus and Buddhists alike. This plant is well-known for its therapeutic capabilities in the Indian system of medicine and the Ayurvedic system of a medicinal preparation. In the Ayurveda system of medicine majority of plant parts (stem, flowers, fruits, bark, seeds, and leaves) of *S. asoca* was used for medicinal properties.<sup>18</sup> The conventional system of medicine, *S. asoca* is described to be utilized in leprosy, eye infection, snake bites, neurological, fever, uterine disorder, neurological, fracture of bones, and cough.<sup>19</sup> *S. asoca* contains (Fig.-8) quercetin, glycosides, kaempferol, flavonoids, epigenin,  $\beta$ -sitosterol, stigmasterol, epigenin, tannins, sterols, saponins, catechin, galliccatechin, leucopelargonidin, procyanidin B1 and B2, catechin, epicatechin, octacosanol, and leucocyanidine.<sup>20</sup>



Fig.-7: *Saraca Asoca*

*S. asoca* bark extracts have been reported for numerous biological activities like anti-microbial, anti-tumor, CNS depressant, anti-helminthic, anti-inflammatory, anti-microbial activity, anti-pregestational, larvicidal activity, anti-pyretic, anti-bacterial, antioxidant activity, uterine infections, rheumatic arthritis, hemorrhoids, anti-cancer, analgesic activities and antidiabetic.<sup>21,22</sup> Bark of *S. asoca* has been reported for the treatment of reproductive disorders in females, some of the Asoka formulations for the management of gynecological disorders. It seems to stimulate the endometrial and ovarian tissue and it can help with menorrhagia caused by uterine fibroids. It must be able to treat a wide range of gynecological issues. Ethanolic extract of *S. asoca* was found to have estrogenic activity, adding to the plant's traditional use in the treatment of female reproductive issues.<sup>23</sup>

***Vitex Neundo***

*Vitex negundo* which belongs to the family verbenaceae contains flavonoids, lignans, terpenes, iridoids, agnuside, negundoside, negundin A, vitexicarpin, steroids, vitexin caffeate, oleanolic acid and volatile oils,  $\beta$ -sitosterol, vitedoin A-B, vitedoamine A, 3,4-dihydroxybenzoic acid, artemetin, vitexin, 5-oxyisophthalic acid, phydroxybenzoic acid (Fig.-10).<sup>24,25</sup> Antiviral, antioxidants, anti-inflammatory, antifungal, antiviral, antihistamine, insect repellent, analgesic, CNS depressant, anticonvulsant, anti-bacterial, antifeedant, anti-filarial, anti-larval, insecticidal, larvicidal, and mosquito repellent are the medicinal properties of *V. negundo* (Fig.-9).<sup>26,27</sup> It's used to treat a variety of ailments such as rheumatism, bronchitis, laxative, and asthma.<sup>28</sup> According to studies, *V. negundo* has significantly increased insulin resistance and hyperglycemia, both of which are frequently associated with PCOS. It also has strong antiandrogenic and estrogenic properties. *V. negundo* has beneficial effects on the ovary, with implications for steroidogenic enzymes, estrous cycle abnormalities, glucose intolerance, the LH:FSH ratio, and cardiovascular parameters, making it an important component in the treatment of PCOS.<sup>29</sup>

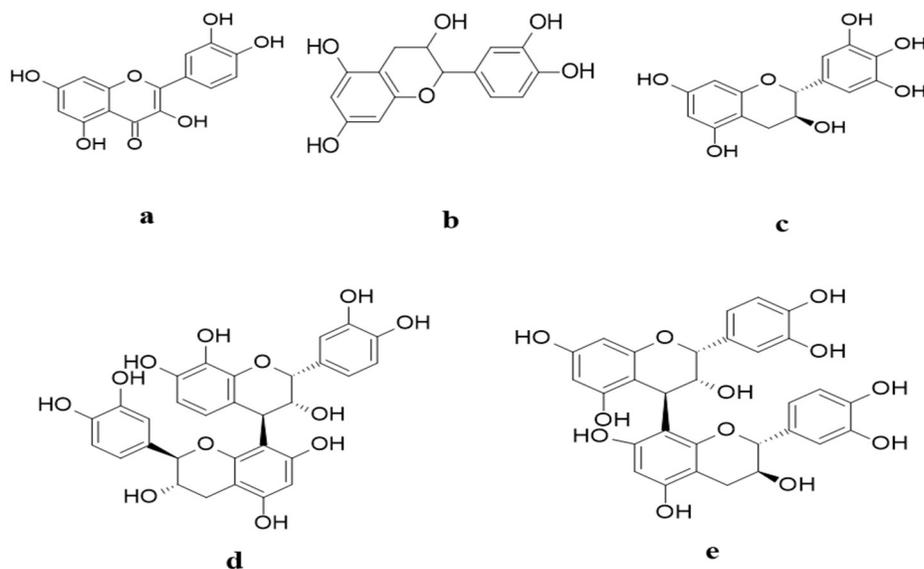


Fig.-8: Structure of (a) Quercetin (b) Catechin (c) Gallocatechin (d) Procyanidin B1



Fig.-9: *Vitex Negundo*

### *Nigella Sativa*

*Nigella sativa*, commonly known as the fennel flower plant (Fig.-11) is a native herbaceous plant of the Ranunculaceae family. Phytochemical components, which are bioactive components of plants include (Fig.-12) carbohydrates, phenolic compounds, tannins, flavonoids, steroids, alkaloids, thymoquinone, terpenoids, dithymoquinone, p-cymene, 4-terpineol, carvacrol, t-anethol, sesquiterpene longifolene,  $\alpha$ -pinene, thymol, nigellicimine, nigellicimine-N-oxide, nigellidine, nigellicine,  $\alpha$ -hederin, carvone, limonene and citronellol.<sup>30</sup> Various pharmacological activities of *N. Sativa* such as anti-microbial effect, gastric ulcer healing, anticancer, antioxidant, gastroprotective, anti-inflammatory, appetite stimulant, immunomodulatory, anti-tumor effects, antitussive effects, hypertension, anti-anxiety effect, asthmatic effect, anti-helicobacter, diarrhea, tumor growth suppression, rheumatism, anti-viral activity against cytomegalovirus, hepatoprotective, headache, asthma, anticonvulsant, pulmonary productive, spasmolytic, dysentery, diuretics, antidiabetic, bronchitis, antihypertensive, anticancer, antioxytotic and analgesic effect have been observed. Oral administration of *N. Sativa* produces antioxidants in HFD/STG induced diabetic rats. Extract of *N. Sativa* was demonstrated to reduce severe weight loss after diabetes.<sup>31</sup>

### *Symplocos Racemosa*

*Symplocos racemosa* is a short evergreen tree (Fig.-13) or shrub with a height of 6-8.5m belonging to the Symplocaceae family. Phytochemical constituents present in (Fig.-14) *S. racemosa* including  $\beta$ -sitosterol,

flavonoids, loturine, salireposide, tannins, loturidine,  $\beta$ -amyrin,  $\beta$ -sitosterol-glycoside, colloturine, linolic acid, proanthocyanidins, symploveroside, leucoanthocyanidins, benzoysalireposide, flavan glycoside, locoracemosides A, B, and C, terpenoids, ethyl substituted glycosides, ellagic acid, salerapin and phenolic glycosides, symconposides A.<sup>32</sup> Ethnomedicinal uses of *S. racemosa* is acne and pimples, mildly astringent, antidiarrhoeal, antidyenteric, flatulence, aphrodisiac, asthma, useful in dropsy, eye diseases, bronchitis, leprosy, elephantiasis, uterine disorders, useful in abortions and miscarriages, filaria, elephantiasis, liver and bowel complaints, baldness, gum bleeding, ear diseases, ulcers, menorrhagia, emmenagogue, scrofula, ulcers of the vagina, gonorrhoea, and leucorrhoea.<sup>33,34</sup> An aqueous extract of *S. racemosa* was found to boost reproductive hormone levels in the blood serum of immature female Sprague-Dawley rats. Rat histopathological studies demonstrated increased folliculogenesis, separated oocytes and mature follicles. These results correspond the drug's conventional use in the treatment of female problems.<sup>35</sup>

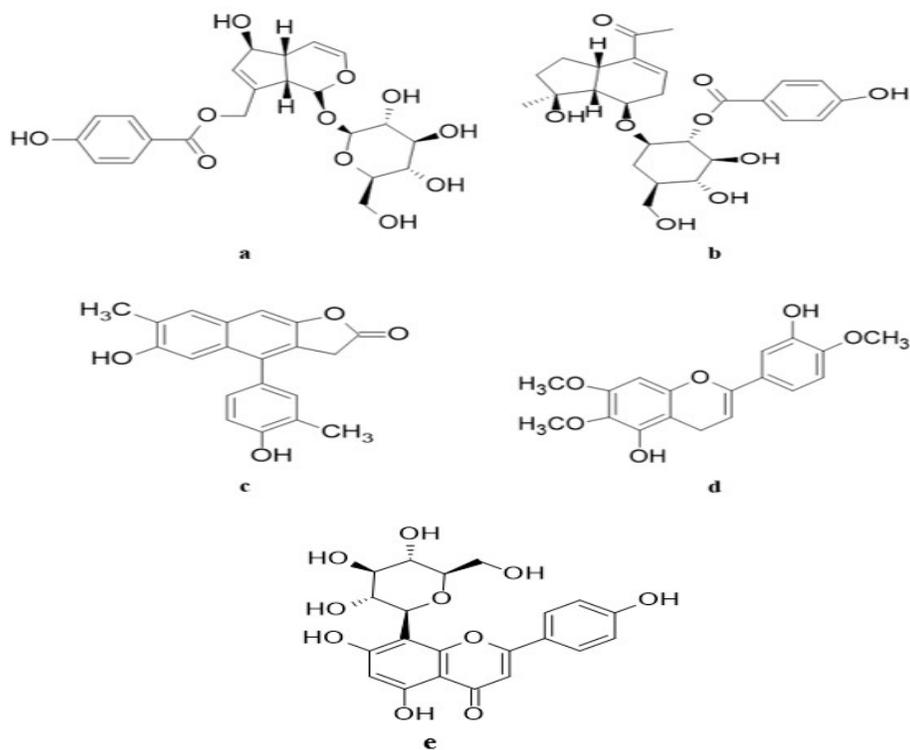


Fig.-10: Structure of (a) Agnuside (b) Negundoside (c) Negundin A (d) Vitexicarpin (e) Vitexin



Fig.-11: *Nigella Sativa*



be used to treat PCOS.<sup>40</sup> Cinnamon supplementation of 1.5 g improved antioxidant status and serum lipid profile in PCOS women, implying that it could be effective in lowering risk factors of PCOS.

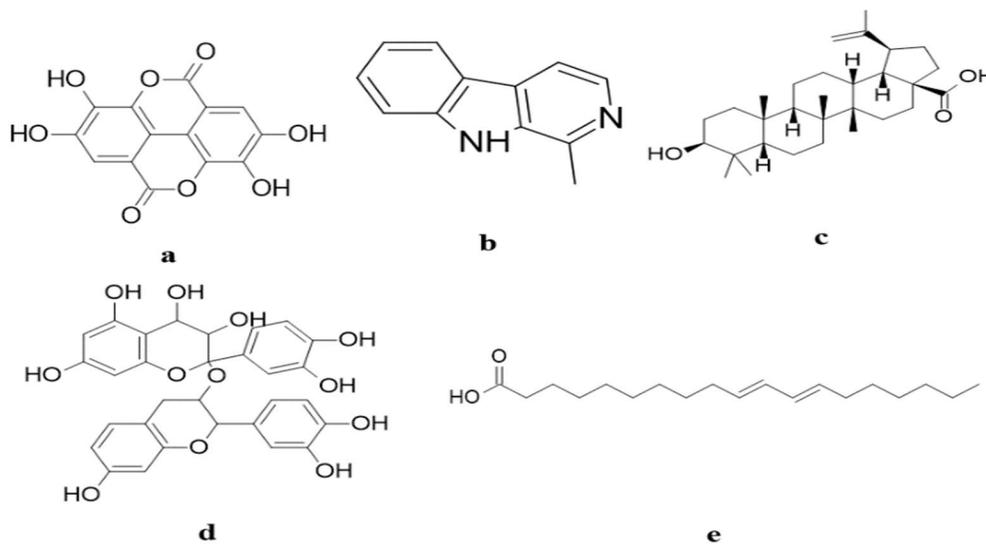


Fig.-14: Structure of (a) Ellagic acid (b) Loturidine (c) Betulinic acid (d) Proanthocyanidins (e) Linoleic Acid



Fig.-15: *Cinnamomum Zeylanicum*

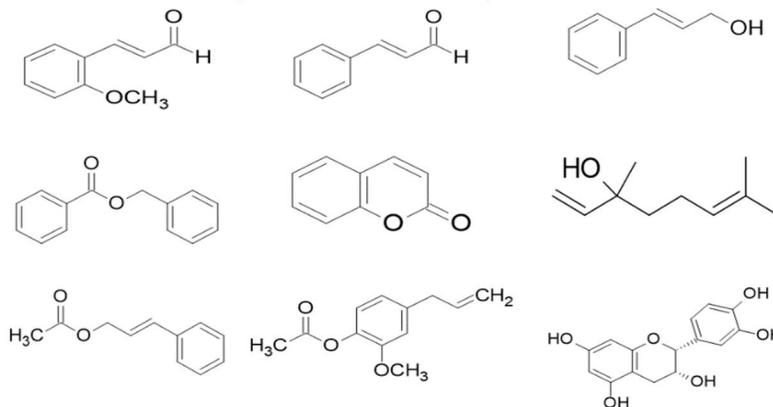


Fig.-16: Structure of (a) Cinnamic Acid (b) Cinnamaldehyde (c) Cinnamyl Alcohol (d) Benzyl Benzoate (e) Coumarin (f) Linalool (g) Cinnamyl Acetate (h) Eugenyl Acetate (i) Procyanidin

## CONCLUSION

PCOS is one of the most common female endocrine disorders, and it can lead to infertility. Herbal medications offer promise in the treatment of PCOS since they provide a consistent impact with few adverse effects. Clinical indices of PCOS comprise infertility, insulin resistance, obesity, menstrual disorders, hirsutism, and acne. The evidence for *Vitex negundo* and *Caesalpinia bonducella* in the treatment of oligo/amenorrhea and infertility related to PCOS is variable and strongest for *Vitex negundo* and *Caesalpinia bonducella*. *Cinnamomum zeylanicum* and *Symplocos racemosa* for improving metabolic hormones in PCOS. *Bauhinia variegata* and *Nigella sativa* improving insulin resistance condition and hypoglycaemic action in PCOS patients. Evidence for *Asparagus racemosus* and *Saraca asoca* gives female reproductive tonic and management of gynecological disorders. These natural medications not only prevent but also heal ovarian cysts. While herbal supplements may take some time to cure PCOS, regular use may help to treat the ailment at its origin.

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