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Polycystic ovarian syndrome: Therapeutic potential of herbal remedies- A review

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Abstract

Infertility due to polycystic ovarian syndrome (PCOS) is a worldwide problem that is increasing at alarming rates. It is characterized by polycystic ovaries, chronic anovulation and hyperandrogenism leading to symptoms of irregular menstrual cycles, hirsutism, acne and infertility. Insulin resistance and elevated levels of male hormones (androgens) are associated with PCOS. The sedentary lifestyle, dietary variations, lack of exercise and stress etc., are also the contributory factors. Various plants like *Panax ginseng*, *Tribulus terrestris*, *Punica granatum*, *Cinnamomum zeylanicum*, *Curcuma longa*, *Cimicifuga racemosa*, *Gymnema sylvestre*, *Trigonella foenum-graecum*, *Cocus nucifera* etc., proved active in the treatment of PCOS. In this review, attempts have been made to summarize the important medicinal plants which are used in treatment or prevention of PCOS. Special attention is given to the role of insulin resistance and the potential utility of insulin sensitizers in management of PCOS.

Keywords: Polycystic ovarian syndrome, letrozole, follicle stimulating hormone, luteinizing hormone, insulin resistance

1. Introduction

Polycystic ovarian syndrome, first described in 1935 by Stein and Leventhal. It is a heterogeneous disorder of uncertain etiology; It is the most common endocrinopathy in women and most common cause of anovulatory infertility, affecting 5-10% of population of reproductive age [1]. Women with PCOS are at increased risk of reproductive abnormalities [2]. It is characterized by hyperandrogenism, polycystic ovaries, multiple metabolic aberrations such as insulin resistance and hyperinsulinaemia [3]. It represents a condition in which an estimate of 10 small cysts of a diameter ranging between 2 and 9 mm develop on one or both of the ovaries and/or the ovarian volume in at least one of the ovaries exceeds 10 ml. Its characteristic neuro endocrine features include increased serum concentration of luteinizing hormone (LH), increased LH/FSH ratio, and increase in amplitude and frequency of pulsatile LH secretion [4]. Increased insulin resistance and compensatory hyperinsulinemia play a key role in the pathogenesis of PCOS. Therefore, insulin sensitizing agents have been studied in the management of PCOS [5]. Treatment of PCOS with the conventional therapy is limited by the prevalence of contraindications, non effectiveness and side effects. So there is always a tendency for the women to follow alternative therapy for the management of PCOS [6]. Currently the standard care treatment for women with PCOS ranges from lifestyle modification to pharmacological interventions. Lifestyle modifications are associated with diet, weight loss, and exercise. Pharmacological interventions include; antiandrogens (Spironolactone, Flutamide), insulin lower agents (Metformin and Thiazolidinediones), and estrogen-progestin combination (Oral contraceptives). Though effective, such treatment is associated with substantial cost and may cause various side effects, such as irregular menstruation, gastrointestinal symptoms, weight gain, and increased insulin resistance [7]. There has been a special attention to medicinal plants since ancient times and today, with numerous studies performed, worthwhile and beneficial medicinal plants are discovered. [8]. As the side effects of these medicines and their identification have significant importance, so many studies including randomized controlled trials, case studies and animal experiments are investigated for herbal drugs.

This review examines the potential of various herbal medicines as an alternative treatment for PCOS, and reveals twenty one herbal medicines with either pre clinical or clinical data for the reproductive endocrinological effects in PCOS and associated oligo/amenorrhea and hyperandrogenism.

2. Herbal Remedies for PCOS

2.1 *Panax ginseng* (Ginseng)

The roots of *Panax ginseng* (Araliaceae) is a traditional eastern herbal medicine. It is used as a tonic and it slow down the ageing properties. The root of ginseng is traditionally used as an adaptogen as it is stated to have the capacity to normalize body functions and strengthen systems that are compromised by stress. The active constituent of ginseng contains ginseng saponins. They are composed of ginsenosides namely Rb1, Rb2, Rc, Rd, Re, Ro, Ra and minor ginsenosides. It is a popular dietary supplement. Pak *et al.*, reported the effect of saponins of red ginseng in rat infertility induced by polycystic ovaries. The researchers induced the polycystic ovary in rats by estradiol valerate. The animals were divide into control and experimental group. The study analyzed the ovarian morphology and nerve growth factor expression. The study concluded that the ginseng total saponins attenuated the NGF (nerve growth factor) expression level in rat ovaries [9]. Among many Kampo preparations, Wen-jing-tang is the one the ginseng containing formulation. One of the study reported that the formulation significantly decreases the plasma LH levels and thereby it is effective in improving endocrine condition in the treatment of disturbances of ovulation in patients with PCOS [10].

2.2 *Tribulus terrestris* (Puncture vine)

Tribulus terrestris, (Zygophyllaceae) commonly known as Puncture vine or Devil's eyelashes plays an important role in traditional medicine. *Tribulus terrestris* was found to be effective in polycystic ovarian syndrome. In an investigation done in rats with polycystic ovaries induced with estradiol valerate, found that *Tribulus terrestris* extract is effective in improvement of ovulation in rats. The extract treatment normalized estrous cyclicity and steroidal hormonal levels and regularized ovarian follicular growth. Many herbalists find *tribulus* is an effective, overall female fertility tonic and ovarian stimulant, making it an excellent choice for women with polycystic ovary [11].

2.3 *Gymnema sylvestre* (Gymnema)

Gymnema sylvestre (Asclepiadaceae) is a herb which is used in traditionally in Ayurvedic system of medicine. It has various pharmacological effects like antidiabetic, hypoglycemic, and lipid lowering effects. The active constituent of gymnema is saponins, especially gymnemic acids. gymnema has potential hypoglycemic activity in experimental models of diabetes. It regulates the blood glucose level. Conventional therapy focusing on metformin therapy for PCOS. Therefore gymnema can be used for the underlying factor of insulin resistance. Gymnema is well indicated for PCOS, due to its insulin modulating activity and the added benefits of reducing the elevated triglycerides associated with PCOS [12].

2.4 *Punica granatum* (Pomegranate)

Pomegranate (*Punica granatum* of the family Puniceae) is one of the known fruit and has numerous medicinal properties. The fruit contains vitamins such as B₂, C, B₁, folic acid, pantothenic acid, sugars, and organic acids. The seed is reported to contain saturated and unsaturated fatty acids. The effect of pomegranate extract in the management of PCOS was performed in adult rats using control and PCOS group. The concentration of serum estrogen, free testosterone and androstanoind hormone levels in experimental group was monitored. The study suggests the beneficial effect of pomegranate extract on hormonal imbalances of polycystic

ovarian syndrome. The phytosterols and phenolic compounds found in the extract have positive effect in improving the complications of PCOS. The study recommends that the consumption of the extract reduces complications associated with PCOS [13].

2.5 *Aloe barbadensis* (Aloe)

Aloe barbadensis Mill. (Liliaceae) popularly known as Aloe vera is a well-known plant with various pharmacological activities. Maharajan *et al.*, reported the efficacy of aloe vera gel formulation for the prevention and management of polycystic ovarian syndrome. The biochemical clinical characters of PCOS were investigated using rat model. The phytochemicals of aloe vera formulation were analyzed for polyphenols, sterols, flavonoids and other nutrients. The rats were then treated orally with the Aloe vera gel formulation. This restored their estrus cyclicity, glucose sensitivity, and the enzyme activity. The histological analysis found that aloe vera decreases the ovary atretic cysts. The results were compared with PCOS control. The studies indicate that aloe vera has potential efficacy in the prevention and maintenance of PCOS [14].

2.6 *Cimicifuga racemosa* (Black cohosh)

Cimicifuga racemosa (Ranunculaceae) is a well known medicinal plant for its estrogenic effects. A randomized controlled study was conducted in 50 women with PCOS. Ovulation induction, hormonal profile concentration and outcome of pregnancy rate were studied. The *Cimicifuga racemosa* extract treatment significantly reduces the LH level and LH/FSH ratio. The reduced LH level decreases the excessive androgen level associated with PCOS, ultimately resulted in better ovulation and implantation rates. Reduced LH increases the sensitivity of ovarian tissue to circulate FSH, which improves the follicular growth, ovulation and implantation. The study revealed that phytoestrogens present in *cimicifuga racemosa* extract increases the endometrial thicknesses, which improve the implantation rate and pregnancy outcome [15].

2.7 *Cinnamomum zeylanicum* (Cinnamon)

Cinnamon (*Cinnamomum zeylanicum* of the family Lauraceae) has insulin potentiating properties. Cinnamon is reported to contain polyphenols and procyanidins. This compound regulates the insulin stimulated glucose uptake and glycogen synthesis. A pilot study conducted in fifteen women with PCOS and then fasting and oral glucose tolerance test values were measured. The cinnamon extract improved the insulin sensitivity in women with PCOS. The polyphenols and procyanidins found in cinnamon extract are responsible for the hypoglycemic effect by potentiating the insulin signaling pathway. The study established the role of cinnamon as an adjunctive therapy in the treatment of PCOS [16]. Another study reported the effect of cinnamon on menstrual cyclicity and metabolic dysfunction in women with PCOS. It was a randomized controlled trial with 45 women. Cinnamon supplement were given orally. luteal phase progesterone level and menstrual cyclicity were monitored. The study has come with the outcome that cinnamon supplementation improved the menstrual cyclicity and it is effective for poly cystic ovary syndrome [17].

2.8 *Glycyrrhiza glabra* (liquorice)

Liquorice (*Glycyrrhiza glabra* of the family Leguminosae) has been used in traditional medicine to treat a wide variety of diseases. It has antibacterial, antifungal, antiviral and

antihyperglycemic properties. Glycyrrhizic acid is one of the important bioactive compounds in liquorice. Liquiritigenin, isoliquiritigenin, liquiritin, isoliquiritin, glabridin, glabrene are some of the phytoestrogens present in liquorice. Somjen *et al.*, reported the effects on vascular tissues *in vitro* and *in vivo* of two natural compounds derived from liquorice root: glabridin, the major isoflavan, and glabrene, an isoflavene, both demonstrated estrogen-like activities. liquiritigenin a selective estrogen receptor ligand might be one of the bioactive compound responsible for weight reduction. Other compounds glabridin and glabrene have showed the effect on weight reduction *in vivo* [18]. It has also been reported that the combined treatment with liquorice and spiranolactone in hirsute women is effective in PCOS, in order to reduce the volume depletion induced by spiranolactone and possibly enhance its antiandrogenic activity [19].

2.9 *Mimosa pudica* (shy plant)

Mimosa pudica Linn belongs to family Mimosaceae is used in folk medicine and traditional systems of medicine in various disorders of female reproductive system. The effect of *Mimosa pudica* extract was evaluated by Letrozole induced PCOS rat model. The biomarkers of ovarian function, plasma testosterone, estrogen and progesterone were analyzed to determine the fluctuations in sex steroid levels in PCOS induced rats. When compared with control, the PCOS induced rats showed characteristic ovary with high incidence of ovarian cysts with a diminished granulosa layer, significant number of atretic follicles and absence of corpora lutea. *Mimosa pudica* significantly reduced histopathological changes in ovary and endocrinological and biochemical changes induced by hyperandrogenism. Thus *Mimosa pudica* was found to have a good potential to be a very good alternative therapy in the treatment of PCOS [20, 21].

2.10 *Matricaria chamomilla* (Chamomile)

Matricaria chamomilla L. from Asteraceae family is a perennial herb in traditional medicine. Chamomile flowers are used as an anti-spasmodic and anti-inflammatory tea for stomach disorders. In women, the antispasmodic effects of Chamomile ease menstrual cramps and lessen the possibility of premature labor. The important constituents of this plant species are volatile oil, sesquiterpene lactones and phenols including flavonoids. Estradiol induced PCOS rat model was used for the study. Circulating levels of gonadotropins and gonadal steroids before and after injection of Chamomile extract in PCO induced were investigated in the study. The signs of PCOS in the ovarian tissue and change in the number of dominant follicles of Chamomile extract administrations were monitored. The histological and hormonal results showed that Chamomile can decrease the signs of PCOS in the ovarian tissue and help LH secretion in rats. The effects of Chamomile extract in rats can be attributed to the flavonoids apigenin by direct activation of the central benzodiazepine site [22].

2.11 *Tephrosia purpurea* (Wild Indigo)

Tephrosia purpurea (Linn) Pers. Belongs to the family Fabaceae is a wild plant known as Sarapunkha in Sanskrit. It has been used for centuries in Indian traditional medicine. The chemical constituents are flavonoids such as tephrosin, pongaglabol, semiglabrin, purpuritenin, purpurea methide, pongamol karanjin lanceolatin B etc. This plant found in Bardi, Aswali region of Maharashtra and it is used by the tribal community for treating female reproductive disorders. A study conducted to evaluate the effect of seed powder of *T.*

purpurea along with milk in modifying, Letrozole induced PCOS in rat. Vaginal smear, FSH, LH, Testosterone, and Estrogen were analyzed and determined the fluctuations in sex steroid level in PCOS induced rats. *T. purpurea* significantly reduced histopathological changes in ovary and endocrinological and biochemical changes induced by hyperandrogenism. The seeds of *T. purpurea* had potential effect on PCOS bringing the reproductive cycle of the rats to normal [23]. Moreover Anti hyperglycemic effects tephrosia has proven in certain studies. In another study, containing tephrosia formulation was found to cause significant results in overall symptoms of the PCOS, that means pain during menses, oligomenorrhoea, follicular size and reduction in polycystic ovary, as well as it also helps in reduction of body weight [24].

2.12 *Symplocos racemosa* (Lodh Tree)

Symplocos racemosa Roxb. From the family Symplocaceae, is a widely used Ayurvedic remedy mainly for gynecological disorders. It is also known as Lodhra and is used in Indian System of Medicine as single drug or in multicomponent preparations. The anti-androgenic properties *S. racemosa* in the treatment of PCOS was investigated in letrozole induced rat model. *Symplocos racemosa* treatment exhibited significant recovery of testosterone, estrogen, progesterone levels and ovarian tissues. Moreover it showed antiandrogenic effect and prevents ovarian cell dysfunction in PCOS and improved the fertility [25].

2.13 Berberine

Berberine, is a isoquinoline derivative alkaloid extracted from medicinal herbs, such as *Coptidis Rhizoma* (Huanglian), *Cortex Phellodendri* (Huangbai), and *Hydrastis Canadensis* (goldenseal), and *Berberis aristata* (Tree turmeric) and possess various pharmacological effects. In Chinese medicine, berberine has long been used for its antidiabetic effects [26, 27]. Wei *et al.*, reported the positive effects of berberine on type 2 diabetes mellitus, insulin resistance, lipid metabolism, nitric oxide production, and metabolic syndrome. The study concluded that berberine, in comparison to metformin, showed similar metabolic effects presumably on amelioration of insulin sensitivity and reduction of hyperandrogenemia. Berberine also appeared to have a greater effect on the changes in body composition and dyslipidemia [28]. In another study compared the insulin resistance in PCOS patients with and without the use of berberine it was a randomized, placebo-controlled and double-blind trial. A total of 120 patients enrolled in the study and randomized into two groups. Berberine and placebo groups. The primary outcome of the study is that women with PCOS have improved insulin resistance following berberine administration [29].

2.14 *Linum usittatissimum* (Flaxseed)

Flaxseed is obtained from *Linum usittatissimum* (Linaceae) a food generally renowned for its omega-3 fatty acid content, also one of the richest sources of dietary lignan. Several biologically active compounds like alpha- linolenic acid (ALA), lignans (secoisolariciresinol diglycoside-SDG), soluble flaxseed fibre mucilage (d-Xylose, L-Galactose, LRhamnose, dgalacturonic acid) which have significant health benefits. The studies on the use of flaxseed or isolated lignan suggest that it may decrease androgen levels and normalize lipid levels. Lignans seem to reduce the excess testosterone which plays a key role in the pathogenesis of PCOS. A case study reported that flaxseed supplementation may indeed help regulate androgen levels in women with

PCOS. A significant decrease in androgen levels was observed in the study. Decrease in hirsutism also observed. Findings suggest that flaxseed may have a profound impact on testosterone levels, and also may diminish symptoms associated with hyperandrogenism, such as hirsutism. Another study reported the effect of flax seeds on ovarian morphology in PCOS and it has showed that flax seed supplementation significantly reduced the ovarian volume, number of follicles in the ovaries and improved the frequency of menstrual cycles. However the study did not find any change in hirsutism, blood sugar level and body weight [30, 31].

2.15 *Silibum marianum* (Milk Thistle)

Silymarin is an active polyphenolic flavonoid extracted from fruits (seeds) of medicinal plant *Silybum marianum* of the family Asteraceae (Milk thistle). Three months of treatment were conducted in sixty PCOS patients in three well-matched groups. Hormonal and biochemical profile of the patients were monitored and compared with metformin. Silymarin is effective as insulin sensitizer improved the ovulation rate. When combination of silymarin and metformin were used, a powerful synergism effect obtained. Study concluded that the addition of silymarin to metformin in treatment of PCOS patients has improving effect on disturbed hormones and ovulation rate. Silymarin may produce its effect on glucose and insulin levels by mechanism through blockage of TNF- α where that serum TNF- α concentration have been high in normal-weight PCOS women and even higher levels in obese women with PCOS [32].

2.16 *Curcuma longa* (Turmeric)

Curcumin is a water-insoluble, low molecular weight, polyphenolic curcuminoid derivative found in rhizomes of Indian spice, *Curcuma longa* of the family Zingiberaceae (turmeric). Turmeric is extensively used as a food additive and coloring agent in Asian cuisine and also in Indian herbal medicine. Curcumin has been reported to possess a wide variety of biological effects like anti-inflammatory, antioxidant hypoglycemic antihyperlipidemic activities and estrogenic effects. A study was conducted in 30 female Albino Wistar rats, using Letrozole-aromatase inhibitor, to induce Polycystic Ovarian Syndrome. Its effect was comparable to that of Clomiphene citrate, most widely used treatment for ovulation induction in PCOS condition. Serum levels of Progesterone and Estradiol were decreased in PCOS induced group. Curcumin restored the hormone and lipid profile, antioxidant and glycemic status as well as ovarian morphology in Letrozole induced PCOS animals. Decreased progesterone levels are also indicative of anovulation and curcumin successfully restore the ovulation. The study suggests that the effects may be attributed to its multiple pharmacological activities like estrogenic, antihyperlipidemic, antioxidant and hypoglycemic effects which could be useful in managing PCOS condition and prevent ovarian cell dysfunction, ovulation and thereby improving fertility. The studies show that the effect of curcumin is similar to that of Clomiphene citrate [33].

2.17 *Cocus nucifera* (Coconut)

Soumya *et al.*, reported the effect of *Cocus nucifera* (Arecaceae) flowers in reducing the major multiple symptoms of letrozole-induced PCOD in female rats. Antioxidant status (superoxide dismutase (SOD) and glutathione reductase (GSH)) of the uterus homogenate, lipid profile (total cholesterol (TC), high density lipoprotein (HDL), low density lipoprotein (LDL), and triglycerides

(TG)) of the serum was determined. Weights of the uterus and ovaries were separately monitored. The characteristics of changes in the ovary were evaluated by histopathological studies. *C. nucifera* flower extract-treated groups showed estrus cyclicity and increased uterus weight which indicates the estrogenic effect. The improved blood sugar level, ideal lipid profile, good antioxidant status, and histopathology results revealed the recovery from poly cystic ovaries. Histological findings of the treated groups indicated that the extract of *C. nucifera* may bring down the active levels of hormones, such as FSH and LH, to normal levels, and that may be the reason for the recovery from experimentally induced polycystic ovaries. This is further supported by the presence of methyl (9Z, 12Z)-9, 12-octadecadienoate which possesses anti-androgenic properties], in the GC-MS analysis of the extract. The GC-MS analysis of the aqueous alcoholic extract showed the presence of twenty-five volatile and semi volatile phytoconstituents. The presence of flavanoid (3, 5-Dihydroxy-6-methyl-2, 3-dihydro-4Hpyran- 4-one), which is responsible for its hypoglycemic effects [34].

2.18 *Corylus avellana* (Hazel nut)

Corylus avellana L., Betulaceae, is growing wild in Europa, Western Asia and Northern Africa as large shrubs or small trees about 3.5–4.5 m high. One of the most important features of *C. avellana* is to have the highest ratio of unsaturated/saturated fattyacids. Demirel *et al.*, reported the activity of the hazelnut oil in the treatment of polycystic ovarian syndrome in rats. Serum follicle-stimulating hormone, luteinizing hormone, estradiol, progesterone, testosterone, serum lipid parameters, leptin and glucose levels were evaluated. The phytosterol content of the oil was determined by HPLC. According to the phytochemical analysis, the main component of the oil was detected as α -tocopherol, tocopherol, squalene, β -sitosterol, campesterol and stigmasterol. Serum gonadotropin levels were determined using radioimmunoassay. After the hazel nut oil administration treatment group and the reference group exhibited regular estrous cycles. It has a favorable effect in controlling follicular cysts. High FSH and LH levels were found to be normal. The ethanolic extract of *C. avellana* seed displayed remarkable antioxidant activity in total antioxidant and radical scavenging tests. *C. avellana* seed regulating the gonadotropins, steroids and serum lipid parameters and possess antioxidant activity. The author suggested that phytosterols determined, probably promoted the treatment of PCOS by their antioxidant effect. The improvement in the blood glucose and serum insulin levels could be associated with the improvement in the serum FSH and LH hormones [35].

2.19 *Labisia pumila* (Labisia)

Labisia is a Malaysian herb thought to have phytoestrogenic effects. It is obtained from *Labisia pumila* (LP), from the family of Myricaceae, It is a subherbaceous plant with creeping stems found mainly in the low land and hill forests of peninsular Malaysia at an altitude of 300–700 m. The water decoction of the plant is taken as a drink by indigenous people of Malaysia for infertility related problems. Manneras *et al.*, investigated the effect of Labisia on body composition and metabolic features in female rats treated continuously with dihydrotestosterone, starting before puberty, to induce PCOS. Extract increased uterine weight and insulin sensitivity. Plasma resistin levels were increased and lipid profile was improved in labisia treated rats. The treatment increased insulin sensitivity, reduced triglyceride and total cholesterol

levels moreover increased uterine weight, indicating estrogenic effects of the labisia extract. Treatment with labisia extract increased insulin sensitivity in PCOS rats without influencing body weight [36].

2.20 *Thuja occidentalis* (White Cedar)

Thuja occidentalis (Cupressaceae) has been used in folk medicine for the treatment of rheumatism, amenorrhea, cystitis, and uterine carcinomas, and as an abortifacient and contraceptive. Thujone found in the essential oil was reported to be responsible for the curative properties of *T. occidentalis*. A recent study investigated the activity potential of the essential oil and its major compound thujone obtained from the leaves of *T. occidentalis* using an *in vivo* letrozole-induced PCOS model. The phytochemical analysis identified the main constituents of the oil is terpene ketones, α and β -thujone, fenchone, and sabinene, as well as the diterpenes beyerene and rimuene. The levels of serum gonadotropins, steroids, blood lipid, leptin, and glucose and the values of antioxidant parameters were monitored in the study. The estradiol and progesterone levels significantly increased, while the LH and testosterone levels decreased in the *T. occidentalis*- and α -thujone-administered groups when compared to the control group. The potential activity of *T. occidentalis* in the treatment of PCOS may be related to its hormone-regulating effect. The study also reported that administration of *T. occidentalis* essential oil and its active component, α -thujone, did not cause osteoporosis development [37].

2.21 *Trigonella foenum-graecum* (Fenugreek)

Another recent study investigated the efficacy of a novel, fenugreek (*Trigonella foenum-graecum* of the family Fabaceae) seed extract in PCOS. Fenugreek is enriched in furostanolic saponins (Furocyst), the trial was conducted in female subjects suffering from PCOS over a period of 90 consecutive days. Plasma glucose levels (fasting glucose), serum triglyceride and HDL levels, total leukocyte count and hemoglobin levels were also monitored at the beginning and end of 90 days treatment. 94% of patients responded positively to the treatment and significant improvement in menstrual cycle was also observed following Furocyst treatment resulted in significant reduction in both ovary volume and ovarian cyst. Also significant increases in LH and FSH were observed following Furocyst treatment. 12% of study population got pregnant. Approximately 46% of study population showed reduction in cyst size, while 36% of subjects showed complete dissolution of cyst. No significant adverse effects were observed [38, 39].

2.22 *Atractylodes macrocephala* (Atractylode)

Atractylodes macrocephala Koidz (Compositae) is a tonic herb widely prescribed in most Asian countries, and it has been clinically used as the dominant herb in most of the Chinese medicinal formula of treating PCOS. The effect of *Atractylodes macrocephala* polar extracts in alleviating hyperandrogenism in PCOS rats was studied. hyperandrogenic rat model of PCOS induced by testosterone propionate is used for the study. The plasma levels of total testosterone, sex hormone binding globulin, androstenedione, luteinizing hormone (LH), follicle stimulating hormone (FSH), antimullerian hormone were measured by enzyme-linked polar extracts. The extract lowers plasma testosterone and androstenedione levels in PCOS. It also significantly reduced LH and increased FSH levels. No adverse effects were found on liver function. The expression of FSH receptors (FSHR) and aquaporin-9 (AQP-9) in the ovaries of

the rats was measured by real-time quantitative PCR and immunohistochemistry. The positive effect of the extract in alleviates the PCOS related hyperandrogenism has been linked to the ovarian expression of FSHR and AQP-9. The phytochemicals of flavonoid glycosides might be responsible for the observed effects [40].

3. Conclusion

Polycystic ovarian syndrome (PCOS) is a common endocrine system disorder in women of reproductive age. A wide variety of risk factors have been investigated in relation to PCOS, which including obesity, glucose intolerance, and dyslipidemia. Insulin resistance is known to play a critical role in the pathophysiology of PCOS. Although so many synthetic drugs are exist for the effective management, their numerous adverse effects and high cost lead a way to seek plant based remedies for the treatment of PCOS.

In this review an attempt has been done to summarize some important medicinal plants for the treatment of PCOS. Many herbal plants have got significant activity in PCOS with fewer side effects. Details of some important plants have collected in this review. Apart from pharmacological therapy, lifestyle modifications are equally important to improve hyperandrogenism and insulin sensitivity. These plants are the “leads” to find out newer synthetic compounds with more therapeutical usefulness. Of course, further investigations should be made towards the isolation, characterization of the active principles, structure activity relationship and mechanism of action to improve the effectiveness and dose management of these biologically important herbal medicines.

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