A Review of Herbal Medicines Used in the Treatment of PCOS: A Breakthrough in Modern Era

By

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A thesis submitted to the Department of Pharmacy in partial fulfilment of the requirement for the degree of Bachelor of Pharmacy. (Hons)

Department of Pharmacy
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Declaration

It is hereby declared that

1.The thesis submitted is my own original work while completing degree at Brac University.

2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate refencing.

3.The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

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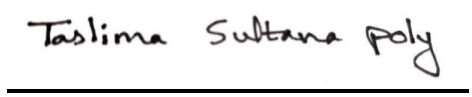

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Approval

The thesis/project titled "[A Review of Herbal Medicines Used in the Treatment of PCOS: A breakthrough in Modern Era]" submitted by Taslima Sultana (17146028) of spring 2017 has been accepted as satisfactory in partial fulfilment of the requirement for the degree of bachelor's in pharmacy on [9th November,2021].

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Ethics Statement:

This study does not involve any human or animal trial.

Abstract:

Polycystic ovarian syndrome (PCOS) is a complex disorder which develops challenges to the women in modern era in terms of the reproductive health and endocrine functions representing a spectrum of complications such as hormonal imbalance, infertility, physical and mental health dysfunction. The actual pathogenesis of PCOS is not clear yet and combination of different medicines are used to treat PCOS, however the alternatives are getting fewer day by day. The dire need of natural source-based cure is on the rise and this study represents few plants which have shown evidence based pharmacological effects against the complications of PCOS. This study includes a total of 30 plant sources which have exemplary potential to restore dysfunctions of PCOS. The active constituents of each medicinal plants are said to play key role and given priority while presenting herbal medicine and summary of each medicinal plant has been provided in this study.

Keywords: Polycystic Ovarian Syndrome, Infertility, Herbal medicine, Natural medicine, medicinal plant, hyperandrogenaemia, PCOS cure.

Dedication

I dedicate this project to my dearest parents who have always showered me with their immense love and support and have been there for me whenever I needed.

Acknowledgement:

At first, I would like to thank almighty for his unlimited mercy and blessing which he showered me with, to make me capable of accomplishing this project work.

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List of acronyms:

PCOS- polycystic ovarian syndrome

PCOM- Polycystic ovarian morphology

OEP -Oestrogen progestin therapy

WHO- World health organization

ICPE- International consortium of paediatric endocrinology

AMH -Anti-Mullerian hormone

CYP450- Cytochrome P450

CYP17A1 17α-hydroxylase

IGF- Insulin like growth factor

DHEA- Dehydroepiandrosterone sulphate

INSR- Insulin receptor

IGF1 -Insulin like growth factor 1

StAR- Steroidogenic acute regulatory protein

3ßHSD - 3ßhydroxysteroiddehydrogenase

SHBG- Sex hormone binding globulin

IGFBP-1- Insulin like growth binding protein 1

VAT -Visceral adipose tissue

FFA -Free fatty acid

AD -Atherogenic dyslipidaemia

ROS- Reactive oxygen species

GSH -Glutathione-s-transferase

MnSOD- Manganese-dependent superoxide dismutase

Mn -Manganese

HIV -Human immunodeficiency virus

AIDS- Acquired Immunodeficiency virus

LH- Luteinizing hormone

FSH -Follicle stimulating hormone

BMP -Bone mineral density

PGR- Progesterone

ESR1- Oestrogen receptor 1

FSHR -Follicle stimulating hormone

CRP -C-reactive protein

NSAID- Nonsteroidal anti-inflammatory disease

Chapter 1: Introduction

Polycystic ovarian syndrome (PCOS) is a complex disease condition where cysts can be seen in one or both ovaries along with the features like menstrual irregularities, elevated androgen levels in the body. PCOS refers to hormonal imbalance which holds the potential to lead to certain other diseases (DiPiro et al., 2004). PCOS is the combination of signs and symptoms called hyperandrogenism and/or hyperandrogenaemia, ovulatory dysfunction and polycystic ovarian morphology (PCOM) (Crespo et al., 2018). It is known to be the most common cause of infertility among women (US Department of Health and Human Services, 2008). World health organization has classified PCOS as group II ovulation disorders which are known as normo gonadotropic, normo estrogenic anovulation and it is caused by the dysfunction of pituitary ovarian axis. It is estimated that 85% women with ovulation disorder fall in the group II ovulation disorder (Dhont, 2005). PCOS is a common condition that affects the function of ovaries. It has three main following features:

1. Irregular menstruation: The ovaries are unable to do ovulation or simply release eggs.
2. Excess of androgen: High levels of male hormones present in the body which may in turn cause excess of facial or body hair in females.
3. Ovaries with cysts: The ovaries become enlarged and contain fluid filled sacs called cysts which surround the eggs. They are often seen to be scattered throughout the whole ovary (National Health Service, 2019)

PCOS is known to be one of the most common metabolic and endocrine dysfunction ever existing in females and prevails in 6-10% of the female populations (Norman et al., 2007). The features of PCOS can either be morphological (more than one cyst in ovary) or biochemical (Hyperandrogenaemia) where hyperandrogenism alone can cause follicular development inhibition, abnormality and changes in menstruation, anovulation and microcyst in ovaries (Ndefo et al, 2013). PCOS is the common endocrine dysfunction that affect the ovarian health of childbearing women between the age of 18-44 years (Teede et al, 2010).

PCOS is also regarded as imbalance of female hormones. In female reproductive system, there are ovary, fallopian tube, and vagina. In the ovary, the eggs are contained. These eggs are often found to be immature and stored in fluid filled sacs called ‘follicles. The pituitary glands release hormones to regulate the release of the eggs from the ovary. It also initiates the release follicle

stimulating hormone and luteinizing hormone each month to direct the menstrual function of the ovary. The immature eggs become mature follicles after the hormones reach the ovary from the bloodstream. These mature follicles help to release female hormone called oestrogen and when the level of oestrogen reaches peak level, the pituitary gland releases a good amount of luteinizing hormone to ovaries. This in turn causes the mature follicles to release the eggs in a process called ovulation. The free egg then travels through the fallopian tube and waits for being fertilized. The remaining immature follicles and eggs end up dissolving slowly. When the eggs are not fertilized, the lining of uterus gets shed along with the immature follicles in the next menstrual cycle and eventually clear up from the ovary through menstruation.

While in women with PCOS, the pituitary gland may release abnormal amount of luteinizing hormone. This in turn hampers normal menstruation process in females in their reproductive ages. The ovulation does not happen and this in turn can lead to infertility. The immature follicles do not dissolve and accumulate as fluid filled sacs or cysts. This fluid filled sacs or ovarian cysts are common in women and often do not possess any harm as they clear up during each menstrual cycle from ovary. But in women with PCOS, there are numerous cysts that accumulate in the ovary. Women with PCOS often have high insulin which is a hormone produced by pancreatic gland. Too much insulin along with luteinizing hormone may lead to the abundant production of male hormone called testosterone increases the risk of inability to ovulate and may lead to infertility (Nucleus Medical Media, 2011)

PCOS can exert multiple effects in the body. The complications presented by PCOS include: High blood pressure, infertility, gestational diabetes, miscarriage, type 2 diabetes, non-alcoholic steatohepatitis, increased triglyceride, depression, anxiety, Pre-mature birth, abnormal uterine bleeding, endometrial cancer, pre-diabetes, eating disorders and lastly, obesity(Mayo clinic, 2020).

Currently, PCOS has no invented cure (National Health Service, 2019) but there are synthetic medications that are available for managing the symptoms. Often, medications that induce ovulation are prescribed to manage the symptoms (Badawy & Elnashar, 2011). In one randomized study with small group of women with PCOS (40 non-obese women), dual therapy of oral oestrogen progestin therapy (OEP) along with metformin showed to improve the symptoms of PCOS. As the disease includes not one but multiple symptoms or pathogenesis,

the synthetic options are often given as combination therapy as the conditions vary from women to women (Elter et al., 2002)

The synthetic drugs have more adverse reactions, and In the United States it is seen that about 8% of the patients are admitted to hospital due to the adverse reaction related to the synthetic drugs. Each year about 100,000 people die due to toxicity caused by synthetic medications in the United States (George, 2011). As the synthetic medications producing more toxicity, scientists are exploring the natural sources in order to treat diseases using herbal or traditional medicines of purely natural sources (Nasri & Shirzad, 2013). The natural or plant sources not only provide staple food to any given population but also contain carbohydrate, protein, fats, and nutrients. They also are rich sources of organic acids, mineral salts, vitamins, enzymes and many co-enzymes (Fernando, 2012). Herbal medicines possess both synergistic and antagonistic effects and cause intervention between the compounds (Williamson, 2001). Plants contain active principles which are able to exert pharmacological effects in the body (Simon mills, 2013). According to WHO, (2019), 80 % of the world's population depends on traditional medicine or medicine derived from natural sources.

1.1 Aim of the study

As there are growing number of scientific journals regarding the treatment of Polycystic Ovarian Syndrome Treatment, this review focuses on combining data of all the natural resources that would provide the reader a thorough knowledge regarding all the natural plant medicine possible. As Polycystic Ovarian Syndrome is a chronic condition, these medicines can be assessed to check the pharmacological action which improves reproductive health in women. As these medicines possess short term as well as long term effects in managing PCOS, they can be re-evaluated, re-studied, and re-assessed for future studies. This review can also help in the future studies which can be related to identification, isolation, purification and protecting the biodiversity of such plants. The modern science can put to use of such plant to explore and manipulate the medicinal plants for improving conditions like low birth rate, infertility, dysmenorrhoea, hyperandrogenism, hirsutism, oligomenorrhoea and all related symptoms of PCOS condition.

Therefore, the aim of this study is to explore the scientific background of the medicinal plants those can be used for the treatment of polycystic ovarian syndrome.

1.2 Objective of the study:

The Objectives of the study are:

1. to explore the ingredients present in each selected medicinal plant.

2. to explore the pharmacological action of those natural resources.

3. to evaluate the mechanism of action of those natural compounds in the treatment of PCOS.

Chapter 2: Methodology

The information gathered for the review were taken from renowned database such as Elsevier, Science direct, Hindawi, PubMed central, NCBI, Google scholar and springer. A thorough search for review papers were done using different keywords. These keywords include “polycystic ovarian syndrome”, “Traditional medicine”, “Herbal medicine”, “Chinese medicine” “chemical composition”, “Mechanism of action”, “Ingredients” etc. These keywords led to useful information through the published articles regarding medicinal values of natural/herbal products used in the treatment of PCOS. Medicinal plants of interest were given priority and chosen accordingly for their usefulness and therapeutic action. Then search for journals in major databases were conducted to compile all the necessary information for those articles. The information, not relevant with this study was discarded from being taken in this study.

Chapter 3: Findings and Discussion

3.1 Pathology of Polycystic Ovarian syndrome:

Along with physiological changes due to Polycystic Ovarian Syndrome, there are also physical changes that are frequently related to acne, abnormal hair facial growth or baldness. The patient with PCOS is prone to Type 2 diabetes, Insulin resistance, heart disease, abnormalities regarding cholesterol and worse is endometrial cancer (Knochenhauer et al., 1998). PCOS is said to be the leading cause behind infertility in women(Ching et al., 2007). The metabolic, hormonal, and psychological disorder caused by PCOS has impacts on the quality of life of patients. Anovulatory disturbances in PCOS can cause infertility in women and ovulatory dysfunction is seen to be prevalent in 100% patients with cases of PCOS.

According to the international consortium of paediatric endocrinology (ICPE) along with other Paediatric Society (Ibáñez et al., 2017) , the complex pathophysiology of PCOS includes many genetic and epigenetic changes along with uterine abnormalities, neuroendocrine abnormalities, insulin resistance, metabolic and endocrine modifiers such as anti-müllerian hormones, adiposity, hyperinsulinemia and finally adiponectin hormone. Excess androgen is one of the primary reasons to blame for PCOS condition along with hirsutism and hyperandrogenism. The following figure (Figure 3.1) shows the Pathogenic factors of polycystic ovarian syndrome.

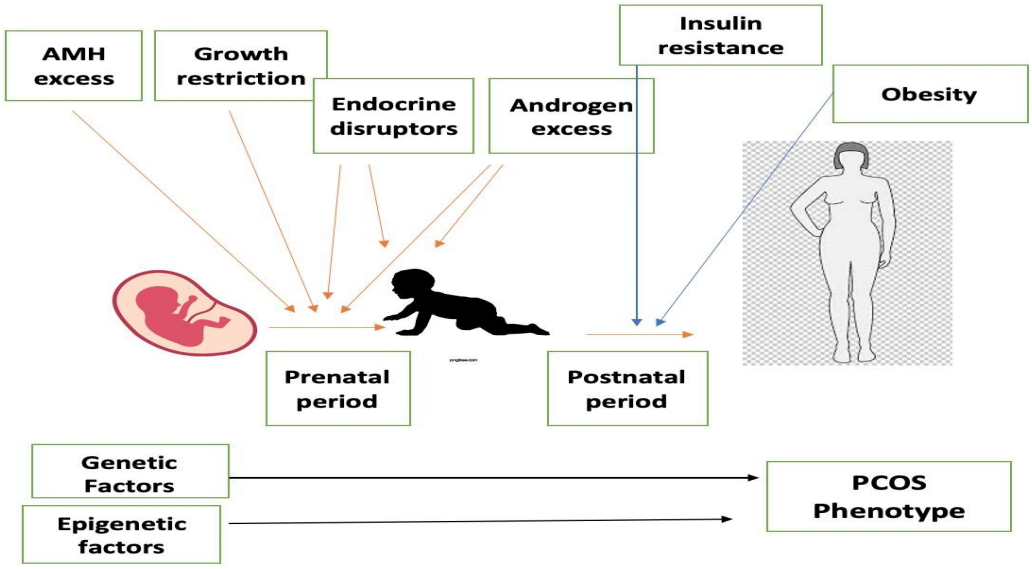

Figure 1: Pathogenic factors of polycystic ovarian syndrome.

This figure shows that factors like anti-mullerian hormone in excess, restriction of growth, endocrine disruptors, excess in androgen hormone release may dispose females into PCOS in their adulthood. The post-natal period for PCOS development is often triggered by Insulin resistance and adiposity or obesity (Sánchez-Garrido & Tena-Sempere, 2020).

3.1.1: Excess Synthesis of Androgen

Increased biosynthesis of androgen can be a core reason to be blamed for PCOS. Theca cells present in the ovaries produce androgen in response to Luteinizing hormone. CYP17A1 gene is expressed by the theca cells, and it encodes for P450C17 enzyme which in turn catalyse the 17α-hydroxylase and 17,20-lyase activity. It is considered as rate limiting step for sex steroid hormone synthesis. With the concurrent increase in the Luteinizing hormone, the androgen production increases with the down regulation of luteinizing hormone receptors and there is decrease in the CYP17A1. In the form of negative feedback loop, oestrogen and androgen produced inhibits 17α-hydroxylase 17,20-lyase activity. On the other hand, IGF'S and Insulin regulated the P450C17 enzyme and up regulated the luteinizing hormone receptor site (Rosenfield & Ehrmann, 2016).

In a normal androgen physiology, the production of equal amounts of androgen are done by adrenal glands and ovary, Ovaries and adrenal glands secrete testosterone directly. Circulating free androstenedione are converted into androgen by both the organs as a response to hormones such as LH and ACTH. Unlike the oestradiol and cortisone secretion, androgen production does not follow negative feedback mechanism but follows intraglandular paracrine and autocrine mechanism. The following figure (Figure 2) shows the effects of luteinizing hormone on the production of androgen hormone.

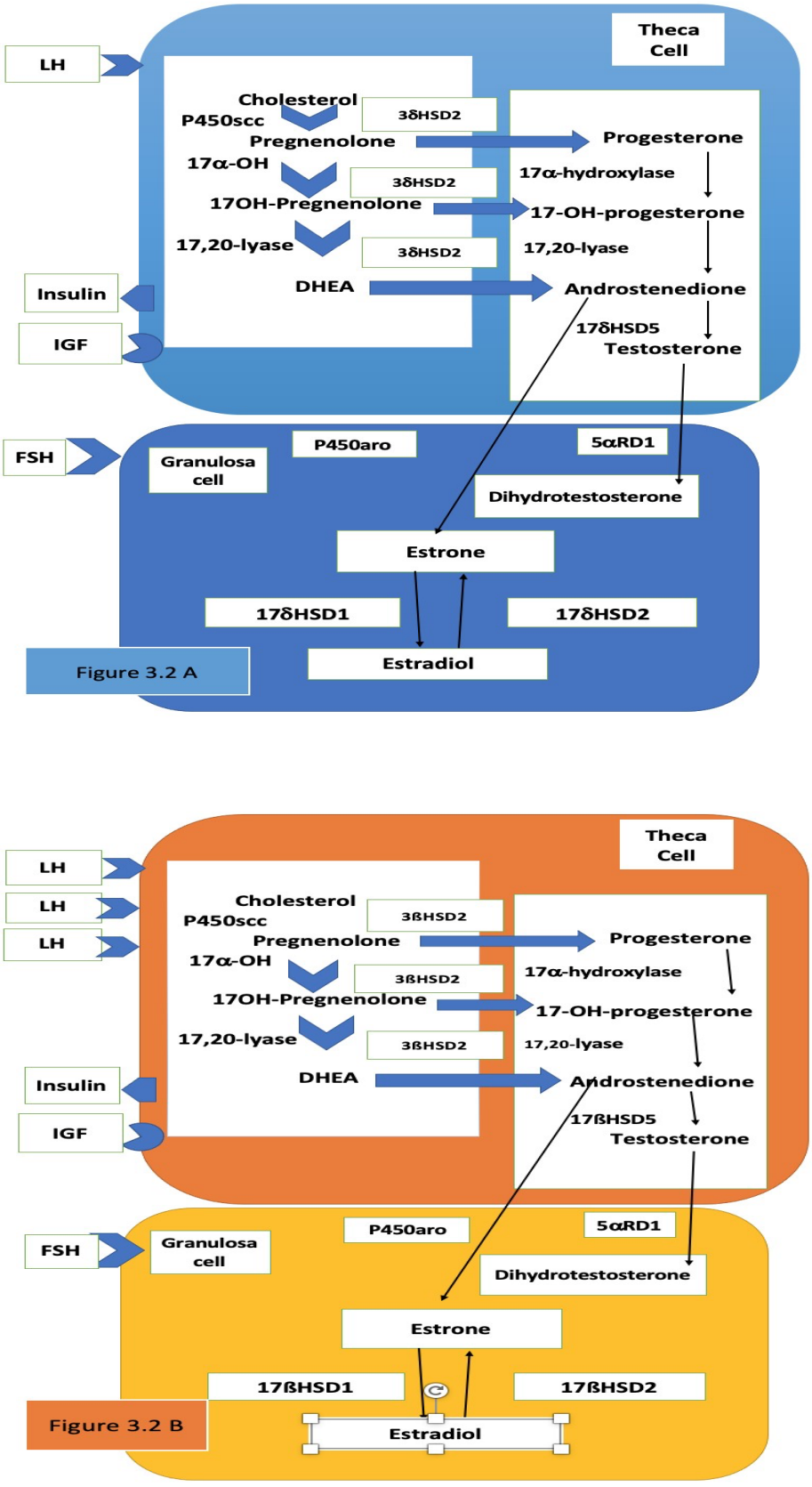

Figure 2:Effects of luteinizing hormone on the production of androgen hormone. Figure 3.2A. Steroid synthesis in normal person and 3.2B. Steroid synthesis in person with PCOS symptoms (Rosenfield & Ehrmann, 2016).

3.1.2. Hyperinsulinemia: A possible cause of PCOS

Hyperinsulinemia is one of the reasons that can contribute or predispose a fertile female in polycystic ovarian syndrome condition. Insulin resistance occurs due to inability to mediate the effects of insulin itself. As a result, more and more insulin is required for attaining the desired metabolic effects. The pancreatic beta cells in response to the metabolic effects produce and release more insulin and try to make up for the metabolic pressure and thus, hyperinsulinemia occurs (Marshall & Dunaif, 2012).

There are INSR (Insulin receptor) and IGF-1(Insulin like growth factor 1) cells present in the ovarian cells and this indicates that it is an ideal site of action for insulin. Insulin along with exerting metabolic action also increase the expression of steroidogenic acute regulatory protein (StAR), P450 side chain cleavage (P450scc), Cytochrome P450c17 (CYP17) and 3βhydroxysteroid dehydrogenase (3β-HSD) by promoting steroidogenesis in the ovary (Mukherjee, S. & Maitra, 2010) The following figure (Figure 3.3) shows the relationship between hyperinsulinemia and hyperandrogenaemia as an underlying cause for PCOS.

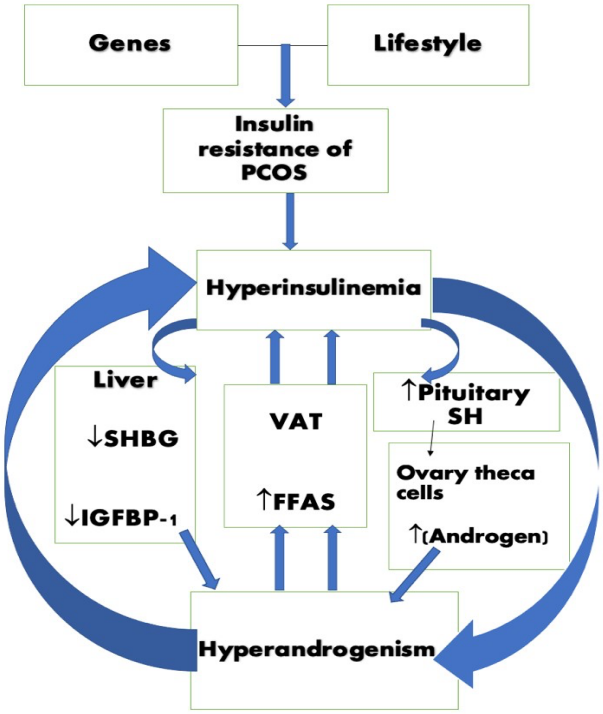

Figure 3: The relationship between hyperinsulinemia and hyperandrogenaemia for PCOS

The androgen pool expands due to hyperinsulinemia which acts on ovarian theca cells directly. In addition, the process reduces the sex hormone binding globulin (SHBG) and Insulin-like growth factor binding protein 1 (IGFBP-1) hepatic biosynthesis. The increased androgen production also exerts effects on visceral adipose tissue (VAT) and increases the free fatty acids (FFAs). This results in more contribution to insulin resistance. All these conditions simultaneously occur and preserves the PCOS state (Shaikh et al., 2014)

3.1.3 Genetic factors of PCOS:

The prevalence of PCOS is said to be 8-13% of the global population depending on the population studied. Many genes are responsible for PCOS condition. It is said to be both polygenic and multi-functional syndrome. PCOS phenotype A and B are responsible for menstrual dysfunction and atherogenic dyslipidaemia (AD). In phenotype C, it is seen that the insulin remains in high concentration, there is atherogenic lipids and high androgen levels and in Phenotype D or Non-hyperandrogenic condition, the androgen levels seem to be normal but endocrine levels seem to be high in CYP19, CYP17, CYP21 and CYP11a are responsible for mutations regarding the PCOS condition (Khan et al., 2019).

PCOS condition was present in both Caucasian and Black population in percentage of 4.0 %. In a study involving 400 women with age range of 15-45 years, it was seen that the black and white females had 6.6% prevalence and white and black females differing from 8% and 4%, respectively (Knochenhauer et al., 1998). This indicates that genetics according to races can contribute to PCOS as well.

3.1.4 Environmental factors which are associated with PCOS:

The environmental factors can predispose one to PCOS condition. Diet and obesity are said to be among the two major reasons for women suffering from PCOS. Food habits and lifestyle determines the obesity and thus can lead to PCOS. There environmental factor studies relating to PCOS are still inconsistent and the field is still yet to be explored by the researchers. Women who are unintentionally exposed to endocrine disrupting chemicals may face estrogenic, antiestrogenic, androgenic, anti-androgenic affects. The endocrine disrupters may exert their actions on membrane bound oestrogen receptors, nuclear receptors, oestrogen receptor. It also

exerts interactions with cytosol, cause endogenous hormone metabolism variation and communication between genomic and non-genomic pathways. And lastly, it interferes feedback regulation. DNA methylation and histone alterations can result from binding to the oestrogen receptor binding site (De Coster & van Larebeke, 2012).

Industrial chemical such as Bisphenol A, which is a known industrial compound of polycarbonate plastics whose exposure to animals and neonatal exposure gave rise to polycystic ovarian syndrome in their adult life. There is association of androgen levels with Bisphenol A which results in endocrine disruption and this in turn contributes to pathophysiology of PCOS, to ongoing infertility problems and hormonal immutability (Kandaraki et al., 2011).

The food packaged with plastic, exposure to pesticides or consuming food produced by pesticides, living near junk heap, eating pericarp fruits, consumption of Chinese medicine such as green tea, cinnamon extract, spearmint, Di long (Palomba, 2018), smoking, drinking habits and lastly working in acid plant may also contribute women to various hazard which can aggravate the manifestation of PCOS itself (Zhang et al., 2014).

3.1.5 Heavy metal as contributing factor for PCOS:

It is previously evident that heavy metal such as lead can cause significant harm to foetal development. There are exposures which are called hobby related exposures and includes gardening (Pesticide exposure), handling pet (dust and soil exposure) (Mitra et al., 2009) and painting (use of acrylic or glass painting) (Kaiser et al., 2001), use of cosmetics such as kajal and lipstick (the main component of kajal is said to be lead sulphide) can cause exposure of women to heavy metal (De Caluwé, 2009)(Neelotpol & Hia, 2016).Metals and trace elements can have negative effects in the human body. Even so, essential elements such as zinc, copper and nickel were found in higher amounts in women with PCOS and elements such as manganese. The reactive oxygen species (ROS) may increase in women due to presence of cadmium which is a known heavy metal and helps formation of ROS. The production of glutathione and enhanced lipid peroxidation and protein bound sulfhydryl group may be activated due to the accumulation of lead (Pb) and aid the production of ROS more. Copper (Cu) acts an enzyme for many redox reactions and can act by increasing oxidative stress and catalyse the formation of reactive oxygen species. Thus, glutathione (GSH) depletion may

contribute to ROS production in patients with PCOS. Thus, a clear relationship between Cu levels and PCOS need to investigate further. Moreover, for manganese (Mn), the mean serum levels of Mn were found to be half of the corresponding serum level and this is assumed that the Mn levels were spent as a result of anti-oxidant defence system which include MnSOD and oxidative stress is seen to be increased in patient with PCOS (Kurdoglu et al., 2011).

This could be a new horizon for the scientists to reveal correlation between PCOS condition and presence of increased or decreased trace elements in the body. Further study done regarding the associating of PCOS, and hormonal alterations revealed that follicle stimulating hormone was seen to be low in women with PCOS but testosterone and cadmium was found in higher concentration in obese women suffering from PCOS condition (A.Taher & Mhaibes, 2017).

There are currently many synthetic medications available for the treatment of PCOS. As the disease includes not one but multiple symptoms or pathogenesis, the synthetic options are often given as combination therapy as the conditions vary from women to women. They are used for the following purpose:

1.**To improve Insulin resistance:** Medication including metformin, Sulfonyl urea, Alpha glucosidase inhibitor, Thiazolidinediones such as Rosiglitazone and Pioglitazone is used.

2. **To facilitate ovulation:** Medications such as Clomiphene citrate (CC), Aromatase inhibitor such as Letrozole and Anastrozole, Glucocorticoids such as prednisone and Dexamethasone, Gonadotropin hormones and lastly, Oral contraceptive pills such include: s norethindrone, desogestrel, and norgestimate are prescribed (Homburg, 2005).

3.**To address hirsutism:** Hirsutism means excess growth of body hair in face, inner thigh, chest and back. Women with PCOS have higher amount of androgen or male hormone and thus the abnormal growth of hair or hirsutism is seen in often cases. Flutamide is used for blocking the androgen receptors which are present in hair follicle cells and deter the androgen to connect with the receptors and thus, hirsutism is reduced. Other anti-androgen medications include the spironolactone, finasteride, and concomitant use of oral contraception (Generali & Cada, 2014).

3.2 Role of Herbal products on PCOS:

Herbal medicines possess both synergistic and antagonistic effects and cause intervention between the compounds (Williamson, 2001).Plants contain active principles which are able to exert pharmacological effects in the body (Simon mills, 2013). Nearly 80% of the world's population depends on traditional medicine or medicine derived from natural sources (Hemalatha et al., 2013) (Namita & Mukesh, 2012). The therapeutic bases that a natural resource provides is undeniably important and provide following importance over synthetic medications:

1. They are abundant and never-ending source natural compounds, salts, ions, and they are easy to assess to provide correct active ingredient and require less efforts to obtain the active ingredients. Raw materials can be formed from simple room temperature and pressures. Among all the plant species present in the world, only 1-10% is consumed by animals and humans as food. The majority can still be assessed to provide more medicinal value and find their vast therapeutic uses as it is still unknown to mankind (Saranraj, 2011) (Saranraj, 2012).

2. Plants contain secondary metabolites which showed synergistic effects when consumed with main medicinal constituent and provided better therapeutic actions. The achieved secondary metabolite may provide stability to the active compounds themselves, minimize the rate at which adverse effects happen, may provide antagonistic effects along with the medications. In fact, the medical use of single entity derived from plants to treat disease are gaining more popularity in scientific fields now-a-day (Mahomoodally, 2013).

3. The Inadequate access to allopathic or synthetic medicines in lower in income countries forced the population and opened window for using the available natural resources in those particular regions. To overcome the costly medical services, the people of Africa turned to the available option such as traditional medicine. The rich biodiversity has abundance of rare natural plant resources which hold potential therapeutic value. Also, there is no modern medical facility available to treat complex and incurable diseases such as HIV, AIDS or malaria and these particular diseases are present mostly in this region. Thus, scientists had no option rather than turning towards medicines of plant origin (Gurib-Fakim & Mahomoodally, 2013).

The treatments that are offered from synthetic resource often seem to lack the therapeutic properties offered by that of natural resources (Gu et al., 2014). Medicines in the past were

formulated using natural sources and included plant extract, leaves, bark, root or even stem of the plant to treat diseases. Plant not only provided staple food to any given population but also contain carbohydrate, protein, fats, and nutrients. They also are rich sources of organic acids, mineral salts, vitamins, enzymes and many co-enzymes (Fernando, 2012). The following tables contains names, constituents, and mechanism of action of medicinal plants that are used for effective treatment of PCOS:

3.3 Medicinal plants used to treat PCOS:

Worldwide, different medicinal plants are used to treat PCOS. These medicinal plants are categorized in terms of twelve herbaceous, shrub, plants, and fungus. For ease in understanding, the medicinal plants have been divided into sections according to being herbs, shrubs, plants, and fungus. Their common names, scientific names along with their constituents are given below:

This section represents herbaceous plant medicines:

1. Fenugreek seed: The scientific name is *Trigonella foenum-graecum* and its constituents are Saponins such as Graecunin, fenugrin B, fenugreekine, steroidal sapinogens such as Diosgenin, yamogenin,smilagenin, tigogenin, neotigogenin, gitotigogenin, yuccagenin, alkaloids such as Neurine, Trimethylamine, trigonelline, betaine, gentianine, caprine and betaine, flavonoids such as Quercetin, rutin, vitexin, isovitexin, fibres such as gum, neutral detergent fibre, amino acids such as Isoleucine, 4-hydroxyisoleucine, leucine, histidine , lysine, L-tryptophan and arginine, lipids such as Triacylglycerols, diacylglycerols, phosphatidylethanolamine, phosphatidylinositol, free fatty acids and lastly other core components such as coumarin, vitamins, mucilage, minerals, bitter fixed oil and proteins (Chatterjee, 2015)(Wani & Kumar, 2018).

2. Soybean: The scientific name is *Glycine max* and its constituents are genistein, daidzein, glycitin, oligosaccharide, trypsin inhibitors , saponins, lectin, phytosterols, □ - glucosides, phytates, glucosides such as acetyl glucosides, malonyl glucosides (Lutz, 2011)

3. Spring onion or welsh root: The scientific name is *Allium fistulosum* and its constituents are Coumaric acid, ferulic acid, Quercetin, ketone, alcohol, aldehyde, β-sitosterol, fatty acid and ester (Liu et al., 2020).

4. Turmeric: The scientific name is *Curcuma longa* and constituents are Curcumene, sesquiterpene, caryophyllene, alpha zingiberene, oxygenated sesquiterpene, turmerone, curlone, beta sesquiphallandrin (Stanojević et al., 2015).

5. Fennel: The scientific name is *foeniculum vulgare* and the constituents include Alpha pinene, myrcene, alpha phellandrene, delta terpinene, fenchone, camphor, methyl chavicol, limonene, trans anethole, fenchyl acetate (Saharkhiz & Tarakemeh, 2013).

6. Dandelion root: The scientific name is *Taraxacam officinale* and the constituents are Sterols, chicoric acid, hydroxycinnamic acid, chlorogenic acid, bauerane, triterpenoids, chlorogenic acid, 18β,19β-epoxy21β-hydroxylupan-3β-yl acetate, 21-oxolup-18-en-3β-yl acetate, caffeic acid, hesperidin, rutin, sesquiterpene, myricetin, vanillic acid, synergic acid, taraxinic acid, officinatrione, betulin, 11-methoxyolean-12-en-3-one, eupha-7,24- dien-3-one, and 24-oxoeupha-7,24-dien-3β-yl acetate (Kikuchi et al., 2016)(Lim, 2016)(Williams et al., 1996).

7. Goat's rue: The scientific name is Galega officinalisofficinalis, and the constituents are amino acids such as lysine, histidine, arginine, threonine, aspartic acid, leucin, threonine, tyrosine, proline, and aspartic acid. Fatty acids such as linoleic, palmitic, lauric acid and alpha linolenic acid (Peiretti & Gai, 2006)

8. Flaxseed: The scientific name is Linum usitatissimum and the constituents include Omega 3 fatty acid, proteins, lignans, dietary fibres and carbohydrates, alpha and beta tocopherols, flavonoids such as flavone c and O-glycosides, cyanogenic glycosides (Bernacchia et al., 2014).

9. Shatapushpa or dill: The scientific name is *Anethum graveolens L.* and the constituents are Proteins, fibres, carbohydrates, fatty oil, essential oil such as limonene, alpha phellandrene, cineole, dihydrocarvone, myristicin, myrcene, paramyrcene, iso-myristicin, moisture, minerals such as vitamin a, niacin, calcium, magnesium, phosphorus, sodium, vicene, glycoside such as dillanoside, falcarindiol, oxypeucedanin (Hojjati, 2017).

10. Liquorice: The scientific name is *Glycyrrhiza glabra* and the constituents include Alkaloids, flavonoids such as liquiritin, liquiritigenin, isoliquiritin, tannins, isoflavanes,

glabrol, liqoflavanone, liquiritigenin, neoisoliquiritigenin, liqoagrochalcones, licuraside, licochalcone, licoisoflavone a and b, glabridine, galbrene (Mamedov & Egamberdieva, 2019).

11. Menthol or pepper mint: The scientific name is Mentha piperita and the constituents include Alpha thujene, sabinene, alpha pinene, verbenene, beta pinene, limonene, linalool, 1,8cineole , p-cymene, cis-sabinene hydrate, methyl acetate, neo menthyl acetate, alpha terpineol, beta bourbonene, alpha gurjenene, beta caryophyllene, alpha-humulene (Marwa et al., 2017).

12. Camomile: The scientific name of Matricaria chamomilla L. and the chemical constituents include sesquiterpenes, flavonoids such as cpolyacetylene, coumarine, phenolic compounds such as herniarin, umbelliferon, caffeic acid and chlorogenic acid, luteolin, apigenin, quercetin, rutin and naringenin are found (Singh et al., 2011).

13. Maca root: The scientific name is Lepidium meyenii and the constituents include Amino acids such as aspartic acid, glutamic acid, lysine, leucine, tryptophan, threonine, tyrosine, phenylalanine, isoleucine, valine, and methionine. Fatty acids such as palmitic, lauric, palmitoleic, palmeic, stearic, linoleic, behenic, arachidic, nervonic, oleic, lignocereic acid. Sterols such as ergosteryl acetate, campesteryl acetate, sitosteryl acetate and brassicasteryl acetate (Dini et al., 1994).

14. Puncture vine: The scientific name is *Tribulus terrestris* and the constituents include Glycosides such as protodioscin and spirostanol, saponins such as tigogein, neotigogenin, gitotigogenin, hecogenin, neohecogenin, chlorogenin, diosgenin, ruscogenin, sarsasapogenin, alkaloids, tannins, flavonoids such as rutin, kaempferol, caffeoyl derivative, quercetin-3-O rutinoside, quercetin 3-O glycoside (Semerdjieva & Zheljazkov, 2019) (Xu et al., 2010).

The following table (Table 3.1) summarizes the name and mechanism of action of fenugreek, Soybean, spring onion or welsh onion root, turmeric, fennel, dandelion root, goat's rue, flaxseed, shatapushpa or dill, liquorice, menthol, camomile and lastly, maca root used in the treatment of PCOS:

Table 1: Name and mechanism of action of medicinal plants used in the treatment of PCOS

Name of the plant:	Mechanism of action:
1. Fenugreek seed (include scientific names here. Is there any local name of this seed?)	It is shown to act on different microorganisms and proved to be anti-microbial. It also has anti-fungal affects (Dharajiya et al., 2016). Fenugreek extracts of seed along with furostanolic saponin (furocyst) treatment showed to reduce ovarian weight with cysts among improved menstrual cycle, regular cyclicity and even pregnancy among 12% within the 90% patients. There is also decreased level of LH and FSH were observed for the case (Swaroop et al., 2015).
2. Soybean	Isoflavones in Soybean shows estrogenic activity (Song et al., 1999).They have ability to act on oestrogen receptors as agonists and antagonists. Asian studies related to epidemiology have found that postmenopausal women with high soy isoflavone intake have greater bone mineral density (BMD) in lumbar spine compared to those with lower intake (Mei et al., 2001). Intake of soy isoflavones for longer than 12 weeks can help improve Insulin profile. Insulin metabolism can be improved along with reduced serum total testosterone, free androgen index, sex hormone binding globulin, very-low-density lipoprotein cholesterol, triglycerides, glutathione, malondialdehyde (Jamilian & Asemi, 2016).

3. Spring Onion or welsh root	Improves PCOS by improving the oestrus cycle. Welsh onion alters the follicle
	stimulating hormone balance and decreases serum luteinizing hormone. It also reduces follicular cysts and increases corpus luteum. The mRNA expression of luteinizing hormone (Lhr), oestrogen receptor 1 (ESR1) and progesterone receptor (pgr) also seen to down regulate (Lee et al., 2018).
4. Turmeric	Curcumin showed apoptotic and anti-proliferative activity against ovarian cancer cell lines (Watson et al., 2010) It protects the porcine ovarian granulosa (Kádasi et al., 2012).
5. Fennel	The extracts of funnel said to decrease the oestrogen present in blood serum and increase the level of progesterone It reduces the epithelial cells present in uterus and increases thickness of endometria. Fennel oil is used for treating many gynaecological disorders such as amenorrhea, dysmenorrhea, menopause, lactation, PCOS and pre-menstrual disorders for its analgesic, estrogenic and anti-spasmodic activity (Mahboubi, 2019).

6. Dandelion root	Dandelion extracts possess the ability to proliferate the granulosa cells present in the ovary which in turn amplifies the expression of mRNA for follicle stimulating hormone (FSHR) and IGF-1R present on the surface of the cells. This effect enhances the ability of ovulation hormone sensitization of ovarian granulosa cells. Dandelion extracts work on downstream regulation pathway for aromatase P450 and aids ovary to produce oestrogen hormone. This results in follicular growth and development of the ovary(Wang et al., 2018). It helps to remove excess of hormones which accumulate in the liver and works as great liver tonic (Mahboubi & Mahboubi, 2020).
7. Goat's rue	It works by reducing pre-antral follicle, cystic follicle, and antral follicles. Following a treatment regimen of goat's rue can help elevate oestrogen and reduce the testosterone, luteinizing hormone and follicle stimulating hormone. It also causes insulin resistance and have marked effects on hyperandrogenism because of flavonoids present in it (Shokoohi et al., 2018).

8.Flaxseed	As flaxseed has highest portion of lignan content, it helps to reduce the testosterone concentration(Johnsson, 2009)(Nowak et al., 2007). It also reduces the level of insulin, oestrogen, and luteinizing hormone by causing ovarian volume reduction. Flaxseed causes reduction of ovarian follicles and improves the menstrual cycle fixing PCOS condition (Nowak et al., 2007).
9. Shatapushpa	Dill has power to cure many gynaecological disorders. Dill also helps to cure diseases like dysmenorrhea, menopause, and infertility (heidarifar et al., 2014).Dill also regulates diabetes mellitus and causes reduction of cholesterol (Hosseinkhani et al., 2018).

10. Liquorice	Liquorice has testosterone reducing power. It has capability to be an adjunct therapy for treating pcos and hirsutism due to blocking of 17-hydroxysteroid dehydrogenase and 17-20 lyase (Armanini et al., 2004)
11. Menthol or pepper mint	Menthol can reduce the oxidative stress and reactive oxygen species effect because they are rich in antioxidants. It helps in the recovery of hormones such as testosterone, luteinizing hormone, oestrogen, and ovarian and uterine tissue. It also helps to restore normal oestrus cycle by producing corpora lutea and promote normal oogenesis (Armanini et al., 2004).

12.Chamomile	Chamomile helps to reduce cyst and helps to grow better endometrial tissue arrangement. The dominant follicles increase whereas the hormones such as LH, FSH, gonadotropin decreases significantly (Farideh et al., 2010).
13. Maca root:	It has enhanced dose dependent affects in the pre-oestrus cycle and works by increasing the luteinizing and follicle stimulating hormone. Maca has fertility increasing ability and can improve the sexual desire also in menopausal women. The surge of luteinizing hormone causes ovulation and helps to develop corpus luteum and this in turn improves fertility (Brooks et al., 2008) (Ruiz-Luna et al., 2005)(Uchiyama et al., 2013).
14. Puncture vine	It has effects to lower atretic follicles and follicular cysts of the ovary. It has pronounced luteinizing effects that can initiate ovulation or create corpus luteum and helps to start normal oestrus cycle (Dehghan et al., 2011) (Dehghan et al., 2011).

The following section represent the Shrub family of trees for the medicinal plants used in the treatment of PCOS:

The name, scientific names along with their constituents of Kuntze or excel, African clove basil, Guduchi, Shatavari, Gurmar, Pomegranate, Raspberry, Labisia, Hazel nut, green tea, and Aloe vera are given below (Table 3.2):

1. **Kuntze or excel plant:** The scientific name is *Phyllanthus muellerianus* and its constituents are Gallic acid, Isoquercitin, caffeic acid, geraniin, furosin, corilagin, astragalin, rutin, phaseic acid, methyl gallate, chlorogenic acid (Agyare et al., 2010).
2. **African clove basil:** The scientific name is *Ocimum gratissimum L.* and the consitituents include Rutin, sabinene, limonene, citronellal, geraniol, alpha thujene, dihydroedulan, alpha cubebene, beta bourbonene, Beta caryophyllene dihydroxy dimethoxy flavone, isorhamnetin, diosmetin, rosmarinic acid, hydroxy trimethoxy flavone, epigenin, dihydroxy trimethoxy methyl isoflavone, Apigenin-C-[6-deoxy-2O-rhamnosyl]-xylo-hexos-3-uloside, strictinin ellagitannin, Methyl epigallocatechin gallate, caffeoyl-hexose-deoxyhexoside (Khaled et al., 2019) (Nakamura et al., 1999).
3. **Guduchi:** The scientific name is *Tinospora cordifolia* and the constituents include Terpenoids such as tinosporide, furanolactone, tinosporaside, diterpene, poly acetate, palmatoside, cordifolioside, sesquiterpenes. Alkaloids such as berberine, tinosporin, choline, jatrorrhizine, choline, palmatine and tembeterine. steroids such as gilointerol, beta sitosterol, lignans, sinapic acid, giloin, octacosanol and tinosporidine (Sharma et al., 2019).
4. **Shatavari:** The scientific name is Asparagus racemosus and the constituents include

   Steroidal saponins, asparagamine, isoflavone, racemosol, vitamin B1 and B2, vitamin A and folic acid, flavonoids such as quercetin, rutin (Verma, 2017).
5. **Gurmar:** The scientific name is Gymnema sylvestre and the constituents include Anthraquinones, acidic glycosides such as gymnemic acid, phytin, anthraquinones, flavones, resin, butyric acid, formic acid, glycosides related to beta amyrin, calcium oxalate, stigmasterol, hentriacontane, pen triacontane and tartaric acid (Tiwari et al., 2014).
6. **Pomegranate:** The scientific name is *Punica granatum* and the constituents include Pomegranate has alkaloids such as pelletierine, methylisopelletieine, tannins such as granatin, casuarilin, corilagin, strictnin, punicalin, punicalagin, anthocyanoside, flavonoids such as quercitol, triterpenic acid, polyholoside and other constituents such as maslinic acid, Asiatic acid, sitosterol, ellagic acid, gallic acid, citric acid, oxalic acid, chlorogenic acid (Health et al., 2018).
7. **Raspberry:** The scientific name is Rubus Idaeus and the constituents include anthocyanins, ellagitannins, minerals such as potassium, iron, folic acid, vitamins such as C, A, B, B1, B2

8. **Labisia:** The scientific name of *Labisia pumilar var. alata* and the chemical constituents that are found include long chains of phenolics, anthroquinones, Larabinose, D-glucose, D-xylose and L-rhamnose, alpha tocopherol, oleic acid, linoleic acid, stearoic acid etc (Bobinaitė et al., 2016).
9. **Hazel nut:** The scientific name *Corylus avellana L*. and the constituents include Folic acid, ascorbic acid, retinol, niacin, vitamin B1, B2 and B6, palmitic acid, oleic acid, linoleic acid, amino acids such as arginine, leucine., gallic acid, beta sitosterol, tocopherol, squalene, stigmasterol, beta campesterol (Köksal et al., 2006).
10. **Green tea:** The scientific name is *camellia sinensis* and the constituents include polyphenols,amino acids, caffein, epigallocatechin-3-gallate,quercetin, catechin, thioflavin, theorubigins, epicatechin and gallocatechin (Bansal et al., 2011).
11. **Aloe vera:** The scientific name of aloe vera is *Barbados aloe* and the constituent are vitamin A.B and C and enzymes which include aliiase , amylase, alkaline phosphate, bradykinase, peroxidase and lipase, minerals such as copper, chromium, sodium, zinc and potassium, polysaccharide such as glucose and fructose, anthraquinone such as aloin, fatty acids and lastly hormones such as gibberellins and auxin (Kar & Bera, 2018).

Table 2: Name and mechanism of action of Kuntze or excel, African clove basil, Guduchi, Shatavari, Gurmar, Pomegranate, Raspberry, Labisia, Hazelnut, green tea, and aloe vera used in the treatment of PCOS:

Name of the plant:	Mechanism of action:
1.Kuntze or excel plant	The phytochemical screening of the dry extract provided key components like alkaloids, tannins, flavonoids, anthraquinones, saponins, steroids and reducing sugars. They are known to possess anti-microbial activity and reduces the PCOS related symptoms (Akiyama et al., 2001). Kuntze plant show affects to restore oestrus cyclicity after short consumption of 14 days. It works by reducing serum level of hormone such as testosterone and luteinizing hormone but again increases the concentration of serum oestradiol. P. muellerians also aromatizes androgen into oestrogen and balances the concentration of androgen present in the body. P. mullerians also helps to stimulate oestrogen guided by adipocytes and induces ovulation improving fertility (Ndeingang et al., 2019).

2. African clove basil	The mechanism of action includes restoration of lipid and hormonal profile along with positive histological changes in the ovary. There is also presence of antihyperglycemic agents such as rutin and isorhamnetin glucoside which reduces the blood glucose level and reduces the vascular endothelial growth factor. It upregulates the aromatase enzyme and decreases the level of androgen which is a prominent characteristic of PCOS (Khaled et al., 2019).
3. Guduchi	The mechanism of action of guduchi plant involves effects like anti-hyperglycemic activity, anti-cancer activity, anti-HIV potential and wound healing. It works by down regulating the blood and urinary level of glucose by attenuating the brain mediated lipid level and reduced the serum lipid levels in diabetic patients (Sharma et al., 2019).Due to guduchi, immature follicles do not get dissolved and form cysts.
4. Shatavari	Shatavari can produce healthy libido and produce hormones for reproductive system. It helps to increase the level of oestrogen hormone for functioning of ovary. It aids in restoring the oestrus cycle in mammals. Shatavari cures condition like dysmenorrhea, amenorrhea by correcting the pituitary gland functioning. For relieving PCOS like symptoms shatavari can improve ovulation, follicular growth and increase apoptosis of the follicle (Pandey et al., 2018).

5. Gurmar	Gymnema plant helps to regenerate the islet cells and has been known as excellent antidiabetic agent. It also lowers the level of serum cholesterol. The ethanolic extract reduced the androgen level in the treated rat group (Pachiappan et al., 2020).
6. Pomegranate	Pomegranate improves female sex hormones by reducing the concentration of hormones such as oestrogen, androstenedione hormone and free testosterone concentration in PCOS patients (Hossein et al., 2015).
7. Raspberry	Rates of serum hormone levels such as testosterone, LH, oestradiol, and CRP were decreased. Increase in the corpus luteum and thickness of granulosa cells indicated an antioxidant and anti-inflammatory activity (Nabiuni et al., 2015).
8.Labisia	Labisia has shown anti-estrogenic and phytoestrogen properties. It helps to increase the weight of the uterus and resistance to insulin, decreasing the expression of leptin mRNA in adipose tissue (Mannerås et al., 2010).
9. Hazel nut	Hazel nut has antioxidant property and can improve the blood glucose and serum insulin level. It can aid the improvement of serum luteinizing hormone and follicle stimulating hormone (Demirel et al., 2016).
10. Green tea	It helps to decrease the weight of body and ovary, serum luteinizing hormone level, resistance due to insulin and also the

	thickness present in theca cells (Abasian et al., 2018).
11. Aloe vera	Helps in the restoration of ovarian steroids, oestrus cycle, alters major steroidogenic activity and glucose sensitivity. It overall provides protective effects against PCOS phenotype (Maharjan et al., 2010).

This section represents the palm plant or trees:

The name, scientific names along with their constituents of Betel nut, Date palm, Coconut palm is given below (Table 3):

1. Betel nut: The scientific name is *Areca Catechu* and the constituents include Arecoline, arecaidine, guvacoline, guvacine (Shrestha et al., 2010).

2. Date palm: The scientific name is Phoenix Dactylifera and the constituents include minerals such as potassium, sugars such as fructose and glucose, amino acids such as aspartic acid, proline, alanine, glycine and valine, threonine, isoleucine, serine, pheynylalanine, tyrosine, arginine, methionine, arginine and histidine (Assirey, 2015).

3. Coconut palm: The scientific name is Cocos nucifera and the chemical constituents include phenols, tannins, flavonoids, leucoanthocyanidins, tannins, polyphenols such as catechins, epicatechins, biotin, nicotinic acid, riboflavin, vitamin b, enzymes such as diastase, dehydrogenase, cytokine and growth promoting factors (Lima et al., 2015).

4.Korean Ginseng: The scientific name is *Ginseng radix rubra* and the constituents include Glycero galacto lipid, steryl fatty acid ester, ginsenoside, panaxynol, panaxatriol, malonyl ginsenoside. Essentials like linalool, oleic acid, palmitic acid. Amino acids, polysaccharide (Kitagawa et al., 1987).

Table 3: Name and mechanism of action of Betel nut, Date palm, Coconut palm and Korean ginseng used for the treatment of PCOS:

Name of the plant:	**The mechanism of action:**
1. Betel nut	Betel nut has known function as abortifacient and shows anovulatory effects. It causes gestational imbalance. Regular intake can cause hormonal imbalance and delay the oestrus and metestrus cycle. This in turn can cause ovulation inhibition. It helps to dilate ovarian blood vessels, adipose and fibrous tissues. It has pronounced vermicide, antifungal, anti-bacterial, anti-septic, euphoria causing, hepato-protective, hypoglycaemic, and astringent properties (Chempakam, 1993) (Nadkarni & Nadkarni, 1954)(Shrestha et al., 2010). It can cause stimulation of hormonogenesis and disorders relating to spermatogenesis (Aritonang et al., 2020).
2. Date palm	It has shown anti-androgenic effects against PCOS. The oestrogen and LH levels lowers and increases the level of progesterone, FSH and primary and antral follicles and lastly, the composition of graafian. This decreases number of cystic follicles as well (Abasian et al., 2018).

3. Coconut palm	Coconut has phytoestrogen and antiandrogen property which helps to increase the weight of the uterus by improving oestrus cycle. It also improves level of blood sugar, helps to
	maintain stable lipid profile and desired antioxidant status (Soumya et al., 2014).
4. Korean Ginseng	Korean red ginseng extracts decreased the ovarian follicles by increasing the corpora lutea and corpora albicantia. It also helps to decrease the ovarian nerve growth factor protein and decreases the mRNA expression nerve growth factor protein (Jung et al., 2011).

The following section represents the perennial fungus family for the medicinal plants:

1. Mitake mashroom: The scientific name is *Grifola frondose* and the constituents include Polysaccharides such as beta glucans and heteroglycans, proteins, polyphenols, alcohols, sterols, and alkaloids (Wu et al., 2021) (Table 3.4).

Table 4: Name and mechanism of action of Mitake mashroom used in the treatment of PCOS:

Name of the plant:	The Mechanism of action:
1. Mitake mashroom	The mushroom said to have anti-tumour properties by polysaccharides (Okazaki et al., 1995). It has been used to treat conditions like hyperlipidaemia, hypertension, and hepatitis (Mayell, 2001). It can be used as monotherapy along with metformin or clomiphene citrate and the ovulation induced

	to reduce PCOS is said to be of gold standard (Chen et al., 2010).

Chapter 4 Conclusion

4.1 Conclusion

In conclusion, the traditional and herbal medicines that are mentioned in this review are some of the remarkable medicines that can impact positively on a complex disease like polycystic ovarian syndrome. These medicines have successfully proved to reduce the symptoms relating to PCOS and can be explore further in the future for more correlation to their mechanism of action and treatment regimen of PCOS.

4.2 Limitation of the study

The limitation of the study is that, not every data regarding individual plant was easily available on internet. Certain data were obtained by cross referencing. The active components or each plant constituent is extremely hard to assess altogether to provide an intact result to make a guide for PCOS treatment. Each plant has different mechanism of action and works differently for different cases. The valuable parts of the plants such as roots, leaves, barks are indistinguishable thus it cannot be cleared which part has presented most active constituent in each study. It is impossible to fit all-natural plants to be included in this study for coming out a better treatment option for PCOS all alone. Data from available sources were encouraged to gather.

4.3 Future Research Plan

As there is a growing demand for plant-based medicine or phytochemical such as herbal medicines to treat new diseases every day, this efficacious medicine should be preserved well, and their natural habitat should not be ruined while working or extrapolating with their medicinal content. It should be kept in mind that these valuable medicinal plant species do not go extinct because of misuse of the medicinal plants. It should be kept in mind that the synthetic drugs require processes which include isolation and identification of pure compounds by hazardous way, on the other hand, these natural medicines do not require such process but still are more efficacious and do not require expensive organic solvents, machines, or higher cost to process them.

The future aspect of this research would like to draw attention of scientists to find out if there are more scope for discovering efficient herbal or natural plant medicine to treat PCOS. The disease still does not have any medication to prevent it but healthy lifestyle, diet, hormonal supplements, sugar lowering medication, proper sleep etc helps to manage the symptoms. The research area regarding ovarian diseases such as PCOS, endometriosis, adenomyosis, endometrial cancer still has huge gap and there is no proper medication to prevent them. Patients often resort to options such as long-term use of NSAID painkillers, Surgical removal of ovarian cyst or part of ovary, removal of fibroids and worst case, hysterectomy. The chemical constituents who possess antiandrogenic, anti-diabetic, antioestrogen property in these natural plants must be understood more clearly so that better focus on these plants may be given for better treatment options. This may help the patients suffering from PCOS as a guide of natural plants to help reducing the symptoms and prevent the disease. These plants can be added to future phytochemical database for better preservation along with the harvesting details and habitat. Documentation of ethnomedicine and natural plants must be done so that further study can be done to treat infertility caused by PCOS. Infertility due to PCOS can be reduced by using these natural plants as an advantage. The market potential along with trading possibilities of the medicinal plants can be taken into advantage by trading possibilities and proper industrial utilization. The real potential of such medicinal plants still waits for the government and entrepreneurs yet to be utilized.

The following suggestions can be applied:

1. More integrated research including in vivo and in vitro studies must be done in order to cure for complex conditions presented by ovarian diseases such as PCOS, endometriosis, ovarian epithelial cancer, germ line tumours of ovary, low malignant potential tumours of ovary, adenomyosis etc.
2. Few medicines mentioned in this article has already been commercialized as a vegetarian medication option or natural medication option for treating PCOS. This includes Shatavari, menthol, camomile or the active ingredients found in these medicinal plants such as riboflavin, vitamins such as A, B, C, D and K and nutrients such choline, flavones, isoflavones niacin and biotin are commercially availed. This industry has growing scope for commercialization. Thus, more focus on natural based products to preserve ovarian health should be given.

3. Signs and symptoms for PCOS is often overlooked unless realised. Early diagnosis is advised with changes in lifestyle, diet, and medication to maintain ovarian health is recommended. The availability of these medicinal plants is widely distributed. Measures should be taken to reduce the misuse of the products with an intention to cure any condition.
4. More concerns should be prioritized for the cultivation and natural preservation of the medicinal plant and reduction of over-exploitation. The natural habitats of these medicine must be preserved.

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