



Efficacy of Herbal Medicine in Treating Metabolic and Endocrine Disorders

MUHAMMAD REHAN SAJID^{1*}, HIRA EJAZ², LAIBA TABASSAM³, FARZEEN AMMARA⁴, HUMA SALEEM⁵, MUHAMMAD SAQIB⁶, RIMSHA IKRAM¹, LAIBA BATOOL¹

¹Institute of Physiology and Pharmacology, University of Agriculture, Faisalabad, Pakistan

²Department of Botany, University of Punjab, Lahore, Pakistan

³Department of Biochemistry, University of Agriculture, Faisalabad, Pakistan

⁴Department of Biotechnology, The University of Faisalabad, Faisalabad, Pakistan

⁵Department of Pharmacy, The University of Faisalabad, Pakistan

⁶Department of Pharmacology and Toxicology, University of Veterinary and Animal Sciences, Lahore, Pakistan

*Corresponding author: rehansajid408@gmail.com

SUMMARY

The therapeutic potential of the various herbal plants plays a crucial role in managing and treating metabolic and endocrine disorders. Plants are rich in different bioactive components like alkaloids, flavonoids, glycosides and terpenoids, which exhibit activity against these diseases via reducing the level of lipids, ameliorate glucose metabolism, combating obesity, enhancing cardiovascular health, regulating estrogen and androgen levels, improving the hormonal imbalances and thyroid stimulating hormone. Studies demonstrated that herbal extracts have shown auspicious outcomes in increasing overall metabolic health and managing hormonal levels via the maintenance of the metabolic balance of the body. Historic applications of herbal plants for centuries emphasize their worth in providing natural and efficient solutions for metabolic and endocrine disorders. The chapter provides extensive information on herbal plants' phytochemical profiles that contribute to their healing properties for curing metabolic disorders such as dyslipidemia, obesity, cardiovascular disease, and endocrine disorders including hypothyroidism and polycystic ovary syndrome. The chapter highlights the significance of exploring plants-based remedies as complementary and traditional medicines, that emphasize a natural approach and minimum side effects of the herbal medicines. Overall, this chapter offers insights on the promising medicinal activities of herbal plants in addressing the broad range of health issues and making them favorable globally for healthcare approaches. This chapter includes the discussion of different kinds of medicinal plants that show their efficiency for treating metabolic and endocrine disorders, and make them valuable for further research and studies in the field of natural medicine.

INTRODUCTION

The worldwide population is facing the escalation of metabolic disorders. The herbal medicines are efficient for managing these disorders effectively and securely (Sharma et al., 2020). The breakdown of food into simpler constituents like carbohydrates, proteins and fats is known as metabolism (Devi, 2021). The disruption in the normal metabolism process is the cause of metabolic disorders. A clump of conditions could be called metabolic syndrome usually occurs mutually and enhances the risk of heart disease and diabetes mellitus. These common conditions are high levels of blood sugar, increased blood pressure, extra fat in the body, and abnormal levels of triglycerides. Metabolic disorders are intimately linked to obesity and insulin resistance (Ferri, 2020).

The therapeutic value of herbal plants is due to the active constituents that are present in them, which have made these

plants valuable as a natural therapy for healthcare for 4000 years. The medicine that is based on natural products presents time-tested and efficient solutions for the treatment of metabolic disorders. Traditional medicine elucidates metabolic disorders and offers curative medicine for a wide variety of metabolic disorders (Sharma et al., 2020). Herbal medicinal plant and their bioactive ingredients have gained great devotion for preventing and managing these diseases with less toxicity. Herbal plants from many eras have been used as medicine for the treatment of diseases (Xu et al., 2020).

There are different metabolic diseases like hyperglycemia, obesity, dyslipidemia, osteoporosis, maple syrup urine disease and hypertension (Niewiadomska et al., 2022). Herbal plant based bioactive ingredients such as alkaloids, flavonoids, tannins, carotenoids, phenols, saponins, terpenoids and glycosides are considered against various diseases like metabolic diseases, neurodegenerative and cancer (Feldman et al., 2021). This chapter mainly highlights dyslipidemia,

obesity and cardiovascular diseases with a focus on various herbal plants used to treat such metabolic disorders.

METABOLIC DISORDERS AND HERBAL MEDICINE/THERAPY

DYSLIPIDEMIA

Dyslipidemia is a metabolic disease of lipids of plasma and lipoproteins (Ference et al., 2020). The overall occurrence rate of dyslipidemia among the citizens of China above 40 years old is 43%. Dyslipidemia is regarded as a risk factor for cardiovascular diseases independently which leads to a higher rate of mortality and disability universally. Advancement in modification of dyslipidemia aids in reducing the diseases and deaths related to cardiovascular diseases. Dyslipidemia treatment by traditional Chinese medicine and herbal plants has been reported (Ibanez et al., 2021). *Crataegi (C.) fructus* and *Mori (M.) folium* have therapeutic potential for the treatment of dyslipidemia as discussed below.

Crataegi fructus

Commonly called hawthorn, is a fully grown dried fruit that belongs to the family Rosaceae. Hawthorn is a red berry that can be converted into juices and snacks, when mixed with sugar and honey, is identified for promoting digestion and boosting appetite. The flavor and nutrients present in the hawthorn make it a healthy and attractive food. It is broadly utilized in the form of jams and canned fruits. It is also widely used in traditional medicine and for producing food for centuries (Wu et al., 2020). It has different pharmacological properties like hypolipidemia, hypoglycemia, anti-inflammatory and antioxidant (He et al., 2021). Hawthorn contains various active ingredients like flavonoids, organic acids, terpenoids, polysaccharides and different chemical elements. The higher concentration of vital minerals and bioactive ingredients like polyphenols makes hawthorn a popular functional food and natural medicine (Dong et al., 2021). Recent studies showed that the bioactive ingredient in *C. fructus* presents a medicinal advantage for cardiovascular diseases with lower adverse effects (Cui et al., 2024).

The extract of hawthorn combined with its polysaccharides can reduce the blood lipids and glucose via inhibition of alpha-glucosidase and lipases of the pancreas. It can lower the level of triglycerides and increase the content of high-density lipoproteins (Qi et al., 2020). Hawthorn extract contains different chemical ingredients like chlorogenic acid, hypericin, rutin, quercetin and vitexin. It can lower the contents of lipids in serum and inhibit the accumulation of triglycerides. Its crude glycoprotein exhibits good lipid reducing effects and antioxidant properties (Gao et al., 2021). The flavonoid extract of hawthorn is vitexin, which can reduce the lipid profile of serum and blood glucose. It cannot only improve the lipid metabolism of blood but also inhibit of construction of foam cells, combat the inflammatory reaction and modulate the gut microbiota (Yang et al., 2021).

Mori folium

Usually called a mulberry leaf, is considered a bared leaf of *Morus alba*. It is regarded to the Moraceae family. Due to its nutritional worth and bioactive ingredients, is popularly utilized in functional food like herbal teas, beverages, and most commonly as noodles in China, Japan and Korea. The mulberry tree is everlasting and greatly valuable and is now harvested in many countries (Zhang et al., 2022). It acquires many biological properties due to a broad range of bioactive ingredients like flavonoids and alkaloids. The pharmacological activities of the mulberry leaf are hypolipidemia, antibacterial, anti-atherosclerosis, hypoglycemia and anti-inflammatory (Zhong et al., 2019). Mulberry leaf includes a broad range of chemical ingredients such as phenols (flavonoids and chlorogenic acid), alkaloids, terpenoids, and polysaccharides. The beneficial functions of the mulberry leaf are directly linked to its chemical components. The active constituents of *M. folium* show cardioprotective properties (He et al., 2019).

The leaf of mulberry can improve the dyslipidemia via promotion of cholesterol efflux and biosynthesis of bile acid. It also promotes the excretion of fecal cholesterol, decreases the content of triglycerides and increases the degradation of lipid hepatocytes. The more potent mechanism that is possessed by *M. folium*, is to elevate the excretion of cholesterol and total bile acid (Hu et al., 2020). Extract of the mulberry leaf contains phenolic compounds like quercetin and kaempferol, that can reduce the triglyceride level and content of low-density lipoprotein in serum via increasing the expression of mRNA of CYP7A1 (Lee et al., 2021). The isolation of chemical constituents from *M. folium* leaf has exhibited a hypolipidemic effect. It has also the efficacy of treating other metabolic diseases like diabetes, obesity, hypertension and fatty liver disease (Meng et al., 2020). The phenolic components of mulberry leaf and its mixture of fiber have shown the effects of lipid-lowering by decreasing the expression of mRNA (Liao et al., 2021).

OBESITY

Obesity is the imbalance of calorie intake and elevation of fat tissue mass in the body. Nutritional administration presents apparent effects on the risk associated with chronic and obesity disease. Obesity influences the quality of life and shows harmful effects that are closely linked with enhancing cardiovascular mortality. Obesity risk is increasing day by day, directly linked to unhealthy food. Many studies reported the administration of edible and medicinal plants has a helpful effect on the loss of weight (Tchang et al., 2021). Herbal plants including *Mangifera (M.) indica* and *Tinospora (T.) cordifolia* explain the treatment of obesity are discussed below.

Mangifera indica

M. indica belongs to the Anacardiaceae family, and is important traditionally and economically. It is a tropical fruit that crops universally. It is usually called mango, indigenous to South and Southeast Asia, and in 2018 the international production of mangoes was 55.4 million masses. This is an evergreen tree, and the countries that produce the mangoes in

largest amounts are China, Bangladesh and Pakistan. Mango fruit is very popular due to its delicate properties like bright color, delicious flavor and sugary taste (Kumaraswamy et al., 2020). The pharmacological activities that are possessed by *M. indica* are anti-inflammatory, antidiabetic, antioxidant, antiviral, and anti-obesity. It has shown action against fungi, parasites, microbes and tumors (Mirza et al., 2020). The phytochemical that occurs in *M. indica* are broadly classified as polyphenols, terpenoids, sterols, carotenoids, carbohydrates and amino acids. The higher quality of bioactive components that are present in mango are polysaccharides, proteins, lipids and vitamins. Total components of phenol regulate various physiological activities, proliferation of cells, enzymatic actions and cellular redox effects for fighting against dreadful pathologies (Luca et al., 2020).

M. indica is the most important plant with anti-obesity action in Indian folk medicine. Mangiferin is the most active biological component of the mango leaves that plays a crucial role in anti-obesity activity. The anti-obesity action of *M. indica* is mediated moderately by inhibition of pancreatic lipase action and partially via decreasing the intake of food and improving the level of antioxidants (Kumaraswamy et al., 2020). Studies have shown that the supplementation of mangoes to thin and obese individuals presented the reduction of the plasminogen activating inhibitor-1, glycated haemoglobin level, and inflammatory cytokine level in obese persons. It controlled the level of blood pressure and showed the positive role of the consumption of mangoes in obese individuals against metabolic diseases and other chronic disorders related to obesity. It is used for treating different diseases like anemia, asthma, bronchitis, leucorrhea, piles and haemorrhage (Barnes et al., 2020).

Tinospora cordifolia

T. cordifolia is a popular herbal plant of Ayurveda that is widely used in therapeutic like a single herb and it is a vital component of polyherbal formulations of Ayurveda. *T. cordifolia* is recognized as an adaptogen, it enhances the resistance of the body to biological, chemical and physical stress, boosting energy and general liveliness (Sharma & Prajapati, 2020). It is regarded to the family Menispermaceae. *T. cordifolia* is indigenous to India, usually known as Guduchi and heart-leaved moon. It possesses biological action against diabetes, inflammation, dyslipidemia and oxidative stress (Singh et al., 2020). The bioactive components that are present in *T. cordifolia* are glycosides, alkaloids, terpenoids, steroids and polysaccharides, and lactones. Phytochemical studies of *T. cordifolia* show that the main active ingredients are tinosporin, choline, palmitine, tinosponone, berberine and isocolumbin (Singh et al., 2021).

It originated as an effective herbal plant, that modulates the body weight in the excessive fat diet via maintaining the energy metabolism and basal homeostasis. Guduchi consists of various chemical ingredients that power the various human body system (Singh et al., 2021). *T. cordifolia* is efficiently presented for the treatment of obesity because it is highly evaluated for anti-obese potency. It includes bioactive components, which are presented for interacting with many

different proteins that are involved in pathogenesis of the obesity like isocolumbin with adiponectin (Mandar et al., 2021). The aqueous root extract of *T. cordifolia* plays a significant role in the prevention of weight gain and presents a hypoglycemic effect. The studies recommended the possible modulation in multiple paths of obesity. It consists of many alkaloids that can reduce triglycerides (Shirolkar et al., 2020). It is one of the ingredients of the folk formulation and possesses potent immunomodulatory, cytoprotective and antioxidant activities that aid in managing disarranged physiological body processes (Sharma et al., 2020).

CARDIOVASCULAR DISEASES

It is the condition that contributes to the accumulation of plaques in the blood vessels of the body that cause disruption of normal blood flow in the host leading to the collection of damaging outcomes such as heart rhythms abnormality, heart valve complexity, failure of heart, stroke and heart attack. Cardiovascular diseases are the major cause of death universally, reporting 32% of deaths approximately according to the WHO in 2021. It is estimated that in the United States of America, one in every three deaths is attributed to cardiovascular disease. Various conditions like coronary heart disease, pulmonary embolism and hypertension have evolved due to cardiovascular diseases (Opoku et al., 2021). Destructive habits of lifestyle like unbalanced diet, lack of exercise, obesity, and extreme smoking are leading causes of cardiovascular diseases (Stevens et al., 2021). *Nigella* (*N.*) *sativa* and *Camellia* (*C.*) *sinensis* have efficacy (Table 1) in treating cardiovascular diseases are discussed below.

Nigella sativa

N. sativa is a flowering plant that grows annually, belonging to the family Ranunculaceae. It grows generally in the countries of the Middle East and Europe. It is usually known as the Black seed and Black cumin seed, is a marvel herb that is used for treating different diseases like hypertension, obesity, cancer and diabetes (Maiden, 2020). The use of *N. sativa* has been very wide in functional food, products of health and medicine for thousands of years. It is popularly suggested for the well-being of people (Rahim et al., 2022). *N. sativa* possesses a broad range of pharmacological activities such as antiviral, antitumor, hypotensive and hypoglycemic (Esharkawy et al., 2022). The biological properties of *N. sativa* are closely related to many different phytochemicals like alkaloids, thymoquinone, saponins, flavonoids, cinnamaldehyde terpenes and essential oil. For disease control and prevention, these auspicious active constituents and their biological activities make the *N. sativa* an influential natural applicant (Ahmad et al., 2021).

The ingredients of *N. sativa* show beneficial pharmacological and antioxidant effects for all risk factors related to cardiovascular diseases. The widely known antioxidant action of *N. sativa* is that it reduces the reperfusion of ischemia injury by reducing the formation of reactive oxygen species in the patient that is associated with coronary heart disease (Ghoreyshi et al., 2020). Studies have shown that the seed oil of *N. sativa* presents antihypertensive activities

Table 1. Overview of medicinal plants used in metabolic disorders

Plant name	Phytochemical Constituents	Mode of Action	References
<i>Crataegi fructus</i>	Chlorogenic acid, vitexin, rutin, hypericin	It acts as hypolipidemia and improve the blood metabolism of lipids.	Gao et al., 2021
<i>Mori Folium</i>	Alkaloids, phenols, terpenoids, quercetin	It improves the dyslipidemia.	Lee et al., 2021
<i>Mangifera indica</i>	Terpenoids, proteins, sterols, polysaccharides.	It shows anti-obesity action by inhibiting the lipases of the pancreas.	Kumaraswamy et al., 2021
<i>Tinospora cordifolia</i>	Glycosides, alkaloids, choline, berberine.	It regulates the body weight and acts as a hypoglycemic.	Singh et al., 2021
<i>Nigella sativa</i>	Thymoquinone, saponins, flavonoids, alkaloids.	It shows anti-hypertensive action.	Shoaei et al., 2021
<i>Camellia sinensis</i>	Caffeine, catechins, flavonoids, tannins.	It acts to improve cardiac function and lower the blood pressure.	Mahdi et al., 2022

and is utilized for beneficial control of glucose effects and metabolism of lipids in patients that have hypertension disease (Shoaei et al., 2021). The oil of *N. sativa* can ameliorate vascular nitric oxide and flow-mediated distention (Emamat et al., 2022). The supplementation of *N. sativa* is very useful in individuals who are obese and overweight, in which it shows an overall amendment in the risk factors associated with cardiovascular diseases (Razmpoosh et al., 2021). It is basically used for the improvement of several diseases like respiratory, digestive, kidney and cardiovascular diseases, in folk medicine (Saadat et al., 2021, Razmpoosh et al., 2022).

Camellia sinensis

C. sinensis is a significant member of Theaceae family. It is basically a flowering plant, for the production of tea their leaves are collected. The plant usually called as tea plant, tea tree and tree shrub, it is indigenous to East Asia, and probably emerging in India and China. The most modern varieties of *C. sinensis* are white tea, green tea and yellow tea (Zhang et al., 2021). The leaves of this tea plant can vary in size depending on the forms, extending 4-5 cm long and 2-5 cm usually wide. The buds and tips of the leaf are harvested for the production of tea and the age of the leaf stimulates the quality of tea (Jiang et al., 2020). Black, green and white tea extracts exhibit great interest in the products of skin care. It possesses antimicrobial, antioxidant, antidiabetic and anti-carcinogenic activities, due to these properties it is used for the benefit of health (de Miranda et al., 2022). The properties related to the promotion of health, prevention of disease and treatment are awarded to the active ingredients that are present in *C. sinensis* are flavonols, polyphenols, caffeine, catechins, theobromine, theophylline, tannins, adenine and gallic acid. The content of caffeine in the tea is approximately 4 percent (Shang et al., 2021).

The flavonoids of black tea can reduce the risk related to diseases of the heart via the prevention of low-density lipoprotein cholesterol oxidation and cause prevention of damage that occurs in the bloodstream and in the walls of an artery. It also causes improvement in the function of cardiac muscle and vasodilation of coronary arteries, minimizing the formation of clots, therefore it protects the heart from cardiovascular diseases. Theaflavins cause a reduction in the markers of oxidative stress like malondialdehyde. *C. sinensis* synthesize epithelial nitric oxide that induces vascular

relaxation (Samanta, 2022). The regular use of tea and its bioactive ingredient like gallate plays a crucial role in decreasing oxidative stress markers and inflammation. It increases the bioavailability of nitric oxide and decreases the blood pressure. Studies stated that the use of two unsweet cups of tea per day delivers the correct quantity of flavonoids for decreasing the progression of cardiovascular disease risk (Keller & Wallace, 2021). Green tea is therapeutically utilized for eliminating thirst, phlegm and heat and shows action as a diuretic and anti-inflammatory. White tea is used for the treatment of measles, diabetes and flu (Xia et al., 2021).

ENDOCRINE DISORDERS

The endocrine system is the vast and most complex network of glands and tissues in the body responsible for secreting hormones for carrying out various functions of the body. This system is located everywhere inside body e.g., neck, chest, abdomen and brain. The endocrine system is involved in regulating the body's metabolism, blood pressure, kidney function, stress response and body fluids. Diseases and disorders related to the endocrine system can disrupt the normal functioning of the body by disturbing hormone production (Graulich., 2024). Endocrine diseases and disorders are increasing globally day by day at an alarming rate. Besides conventional medicines, phytomedicines due to their potent chemical constituents possess the potential to cure and manage endocrine related issues (Table 2). Plant medicine's natural powerful abilities captured the researcher's attention to make a healthy approach toward cure and health (Al-Zarzour et al., 2022). A lot of plants have the potential to treat various endocrine related diseases and disorders. We'll discuss a few plants which are helpful in the treatment of endocrine disorders (Hypothyroidism and Polycystic Ovary Syndrome).

HYPOTHYROIDISM

In simple words, hypothyroidism is the deficiency of thyroid hormone. But if this deficiency is left untreated, it can cause serious health issues which can affect many organs of the body. Thyroid hormone is so important as it plays a crucial role in normal tissue development and regulation of metabolism of almost every cell and organ of the body. Hypothyroidism develops silently and its symptoms occur late as the issue progresses (Chaker et al., 2022). Symptoms could be mild to fatal. Some typical symptoms include fatigue,

Table 2. Overview of medicinal plants used in endocrine disorders

Plant name	Phytochemical Constituents	Action	References
<i>Withania somnifera</i>	Alkaloids, Flavonoids, Glycosides, Triterpenes, Saponins & Tannins	It acts by improving the production of thyroid hormones.	Mikulska et al., 2023
<i>Costus pictus</i>	Flavonoids, Phenolic acid, Alkaloids, Glycosides, Triterpenes, Tannins & Steroids	It stimulates the thyroid gland to produce and secrete thyroid hormones.	Selvakumarasamy et al., 2021
<i>Commiphora mukul</i>	Alkaloids, Saponins Terpenoids, Flavonoids, Lignans & Steroids	It has the potential to initiate the production of thyroid hormones and helps in cold intolerance.	Shah, 2023
<i>Curcuma longa</i>	Polyphenols Alkaloids, Sterols Diterpenes, Tri-terpenoids and Sesquiterpenes	It lessens the follicular sheath and enhances the ovulation process and corpus luteum development.	Lakshmi et al., 2023
<i>Panax ginseng</i>	Polysaccharides, Glucosides, Phenolic acids, Saponins & tri-terpenoids	Elevates estrogen receptor activity and inhibits FSH & LH levels.	Lakshmi et al., 2023
<i>Linum usitatissimum</i>	Omega-3 fatty acid, Phytoestrogenic-lignans, Sterols, Phenols, Proteins, Flavonoids & Glycosides	It lowers the increased levels of Testosterone and androgen hormones. Reduces Hirsutism. Helps in the regulation of the Menstrual cycle.	Lakshmi et al., 2023

weight gain, change in person's voice, cold intolerance, constipation and dry skin. Females and older people are more likely to develop hypothyroidism (Wilson et al., 2021). Plants that have the potential of managing and treating hypothyroidism are discussed below.

Withania somnifera

Usually known as Ashwagandha or Indian ginseng or Indian winter cherry belongs to the family Solanaceae. This therapeutic plant lives in Indian subcontinent regions. *Withania (W.) somnifera* means “sleep inducer” in Latin because of its sleeping effect on consumption. In Sanskrit (the holy language of Hinduism) “Ashwa” stands for horse and “Gandha” stands for wet, assumed to refer to the smell of root. Some sources say that it is called Ashwagandha because on consumption it gives a person horse like strength. Ashwagandha alone and in combination with other herbal medicines has been in use for over 3000 years in the Indian medicine system. It is rich in various potent phytochemicals which possess many biological effects. Being abundant in a wide range of active phytochemicals, Indian ginseng has many biological actions such as anti-inflammatory, anti-diabetic, anti-cancer, anti-microbial, anti-stress, anti-arthritis, hepatoprotective, cardio-protective, neuro-protective and immunomodulatory properties. It has also shown the ability to decrease ROS (Wiciński et al., 2023; Mandlik & Namdeo, 2021). This anciently important plant contains active compounds such as alkaloids, flavonoids, glycosides, triterpenes, lipids, reducing sugars, coumarins, amino acids, phytosterols, saponins, fatty acids, carbohydrates, phenolic acids, starch, steroidal lactones (Withanolides and their derivatives), tannins, volatile oils and phenols (Shinde et al., 2023; Wiciński et al., 2023).

Thyroid diseases are one of the major problems of the current century. Hypothyroidism is becoming more common day by day. *W. somnifera* has been proven to have the potential to lower the production of thyroid hormone in blood and can manage glucose metabolism which is usually compromised in thyroid disease. Indian ginseng is one of those therapeutic plants which is free of iodine. Iodine is responsible for encouraging the thyroid gland to make and secrete T3, T4 & TSH hormones. Ashwagandha has been shown to be more

useful in treating subclinical hypothyroidism as compared to advanced hypothyroidism. Regardless of this, ashwagandha still can be used as a side supplement in the conventional treatment. The compound that grants ashwagandha therapeutic potential is withaferin A. This compound's antioxidant potential manages and standardizes the function of the thyroid gland. A study was conducted for 8 weeks on a total of 50 subjects, in which half were given an ashwagandha supplement and the other half were given a placebo. At the end of the trial improvement was shown in T3, T4 & TSH levels in subjects who were on ashwagandha supplement. This proved that this plant is useful in treating subclinical hypothyroidism (Mikulska et al., 2023).

Costus pictus

Well known as the “insulin plant”, is a member of the family Costaceae. Other common names of *Costus (C.) pictus* are spiral flag, step ladder and fiery Costus. This therapeutically important plant grows all over the tropical regions of the earth. As was previously noted, the Zingiberaceae family was assigned to all of the Costus species. Later, after numerous more floras were added, Costaceae were divided into a subfamily within Zingiberaceae called Costoideae. The genus Costus saw the inclusion of genera such as Dimerocostus, Monocostus, and Tapeinochilus, which led to the formation of the Costaceae family from the Zingiberaceae family, which explained the rationale behind the classification of the Costaceae as a distinct family. *C. pictus* is a perennial herb with rhizomatous roots. This is grown, ideally in the shade, on rich, moist soils. It grows best in a tropical area with high humidity and temperatures of about 13 °C. The leaves are oblong-lanceolate in shape and have a straightforward spiral arrangement. A leaf's typical length is between 10 and 25 cm, while its typical breadth is between 2.5 and 6 cm. This plant has been used since ancient times because of its antiseptic, diuretic and carminative activity. Its rhizomes are used in the treatment of various health issues. Insulin plant has anti-diabetic, antioxidant, anti-cancer, anti-inflammatory, hepatoprotective, anti-microbial, anthelmintic, anti-adipogenic, antifertility and hypothyroidism treating potential (Selvakumarasamy et al., 2021).

Insulin plant is abundant in flavonoids and phenolic acids. Alkaloids, glycosides, triterpenoids, tannins and steroids are also present in it. Flavonoids and phenolic acids are involved in most of the therapeutic effects, performed by this plant (Selvakumarasamy et al., 2021). Thyroperoxidase and 5'-deiodinase were two of the hormones whose expression was increased by the methanolic leaf extracts of the insulin plant, which stimulated the thyroid gland to produce and secrete thyroid hormones. β and α amyrins are two pentacyclic triterpenes found in nature, and they are supposed to be responsible for this effect on the thyroid gland. Nuclear factor- $\text{NF-}\kappa\text{B}$ activation is inhibited by α and β amyrins; this suppression may hinder the T3-dependent induction of 5'-deiodinase gene expression. An increase in thyroid hormone levels resulted from these (Selvakumarasamy et al., 2021).

Commiphora mukul

Commonly known as guggulu and guggul, is one of the ancient and the most used medicinal plant in Ayurveda. *Commiphora (C.) mukul* belongs to the family Burscraccae. It is among the fundamental folk resin medicine. Resin means volatile oil which is a usual metabolite or secretion of plant tissues, cells, resin channels or ducts. The resin of this plant is rich in biologically active compounds and is responsible for therapeutic effects. This plant usually grows in dry areas of India, Pakistan, Bangladesh and less commonly in Eastern Africa and Arab regions. Guggulu has been mentioned in Vedas (Sacred scripture of India) for more than 3000 years for its medicinal properties. *C. mukul* has antioxidant, anti-inflammatory, nervous system protection, anti-bacterial, hypolipidemic, bone resorption, myocardial protection, anti-obesity, hepatoprotective, anti-arthritic, cytotoxic, anti-atherosclerotic, anti-psoriatic, anti-hemorrhoid, anti-fertility, anti-acne, anti-urolithic and thyroid stimulating potential (Garang et al., 2023; Sunita et al., 2023).

Biological active compounds of guggul consist of alkaloids, saponins, carbohydrates, terpenoids (mono-, di- & tri-terpenoids), lignans, lipids, steroids (Z-guggulsterone and E-guggulsterone) and flavonoids (Eraj et al., 2020; Malik & Mandal, 2024). Scientific studies have been conducted to understand the benefits of Guggulu in induced hypothyroidism patients. It was shown that *C. mukul* has the potential to initiate the production of thyroid hormones T3 and T4 and in turn, ameliorate the symptoms of hypothyroidism. This plant's hypolipidemic potential is also linked to its thyroid stimulating activity. Its therapeutic constituent, guggulsterone (ketosteroid) counteracted the thyroid suppressant activity of the inducer. *C. mukul*'s thermogenic effect helps in cold intolerance which is usually compromised in hypothyroid patients. It also showed no toxic effects in patients, making it a safe and effective natural treatment against hypothyroidism (Shah, 2023).

POLYCYSTIC OVARY SYNDROME (PCOS)

PCOS, also known as polycystic ovarian syndrome, usually begins in teens and is characterized by ovarian malfunction and hormonal imbalance. PCOS affects 8% to 13% of women who are of reproductive age and is the most common endocrinologic illness in women. Despite being quite

common, this perplexing illness has challenges for both diagnosis and treatment because the main symptoms may vary with age and because the treatment plan must be tailored to the individual needs of each patient. The clinical phenotype is characterized by signs and symptoms of excess androgen, irregular menses, chronic anovulation, and infertility. Diabetes mellitus, obesity, dyslipidemia, hypertension, anxiety, and depression are all more common in women with PCOS. PCOS affects women's health at every stage of life, starting before conception and continuing into the postmenopausal years.

The pathophysiology of PCOS is complex and multidimensional, involving environmental, genetic, and intergenerational variables. These sources drive the fundamental mechanisms of unbalanced hypothalamus-pituitary-ovarian axis communication, which promotes hyperandrogenism in the adrenal and ovarian glands. Insulin resistance is another feature of the illness, and it is made worse by the accumulation of adipose tissue and hyperandrogenism-related dysfunction, such as lipo-toxicity and oxidative stress. Therefore, throughout the complete clinical spectrum of the disease, problems related to metabolism, reproduction, and psychology are evident. In addition to hereditary characteristics, environmental factors most likely play a role. PCOS is more common in women with a body mass index (BMI) of above 30 kg/m² (14%), compared to 4.3% in those with a BMI of less than 25 kg/m². This suggests a substantial association between obesity and PCOS prevalence. On the other hand, selection bias could affect the evaluation procedure.

Research involving both human and animal subjects suggests that the illness may run in families since daughters of mothers with PCOS are five times more likely to develop the condition (Hoeger et al., 2021; Witchel et al., 2020). Available therapies for PCOS are not so beneficial due to the commonness of contraindications in women with PCOS, failure of treatment in some cases and sometimes severe side effects. This drawback is bringing the attention of women towards alternative treatments such as Ayurvedic treatment. Because it is a natural way of treating disease without any unnecessary side effects. Over the past ten years, women's acceptance and use of alternative medicine has climbed from 26 to 91%. Global health debates are now bringing the world's attention toward traditional herbal medicines for the treatment of various issues including PCOS (Pachiappan et al., 2020). Plants that proved themselves beneficial in the treatment of PCOS are discussed below.

Curcuma longa

Following a thorough analysis of the literature, *Curcuma (C.) longa* is acknowledged as a miracle herb in herbal medicine with a broad spectrum of pharmacological properties. It is commonly known as "Haridra" and "Haldi". Turmeric, or *C. longa* of the Zingiberaceae family, is an annual herb with big oblong leaves and oval, elliptical, or pyriform rhizomes that are occasionally branchy and brownish-yellow. The plant has a tiny stem. It is extensively grown in Asia, namely in China and India. It is most commonly used as a spice in many dishes worldwide. Turmeric has been used in India for about 4,000 years; its use dates back to the Vedic era. Turmeric

is frequently used as a home remedy for a variety of illnesses in Siddha, Ayurveda, and Unani. Turmeric is a native of Southeast Asia and is used as a spice, preservative, and for coloring in countries in Asia, including China, Bangladesh, and Southeast Asia. China, Bangladesh, Taiwan, Myanmar, Sri Lanka, Nigeria, Jamaica, the West Indies, Australia, Peru, and other Caribbean and Latin American countries are the main growing regions for *C. longa*. Around 78% of the world's turmeric is produced in India, the country that grows the most of the spice. It is also the biggest importer and user of turmeric worldwide.

In traditional Hindu medicine, turmeric is often used to relieve sprains and edema caused by injury. Numerous therapeutic effects, such as anti-tumor, cardioprotective, and neuroprotective qualities, as well as antioxidant, anticancer and antibacterial qualities have been shown. Additionally, haldi has demonstrated anti-angiogenic, anti-diabetic, anti-allergy, and anti-protozoal actions in sexually transmitted infections, in addition to their anti-inflammatory, anti-acidogenic, and radioprotective potential. Numerous clinical studies have suggested that curcuminoids (biologically active compound) may hold therapeutic potential for treating a range of chronic illnesses, such as inflammatory bowel disorders, lung cancer, breast cancer as well as colon cancer (Jyotirmayee & Mahalik, 2022).

Turmeric is rich in active phytochemicals such as polyphenols, alkaloids, sterols, diterpenes, triterpenoids and sesquiterpenes. Curcuminoid, a phenolic compound of turmeric is responsible for its yellow color. Curcumin (77%), desmethoxycurcumin (17%), bis-desmethoxycurcumin (3%) and cyclocurcumin (a minor ingredient) are the four primary curcuminoids. Turmeric's active phytochemical, curcumin is mostly responsible of its therapeutic effect (Iweala et al., 2023). Curcuminoids have a major impact on PCOS treatment. They lessen the follicular sheath and enhance the ovulation process and corpus luteum development. Turmeric thereby enhances the histological characteristics of polycystic ovaries. In women with PCOS, curcuminoids also raise the levels of estrogen and inhibit progesterone in the serum. Additionally, its hypoglycemic, antioxidant, anti-hyperlipidemic, and estrogenic properties help to manage PCOS and prevent ovarian cell malfunction, which in turn improves ovulation and fertility (Lakshmi et al., 2023).

Panax ginseng

Commonly known as ginseng, is titled “Queens of all Herbs”. It is also known as Korean ginseng. *Panax (P.) ginseng* belongs to the family Araliaceae. Being rich in therapeutic potential, this queen of herbs has been used for over 2000 years in eastern countries (B. de Oliveira Zanuso et al., 2022). Since ginseng grows well in the mountain woods of the northern temperate zone of the Far East, it is grown and/or harvested in Russia, America, China, Korea, and Japan. There are two types of oriental ginseng: white and red. Nowadays, ginseng is grown commercially in 35 different nations worldwide. Asian ginseng (*P. ginseng* C.A. Meyer), which includes the “White” variety of China ginseng, the “Red” variety of Korean ginseng, and the *Quinquifolium* variant of

American ginseng, is the species that is most commonly utilized. However, *Eleutherococcus senticosus* of Siberia, a substitute for ginseng that is thought to have similar qualities, should not be mistaken for *P. ginseng*. Chinese people believed ginseng to be a cure for every illness. Ginseng was utilized as an energy booster, aphrodisiac, and anti-aging tonic in the past. It is also used for its antioxidant potential. It was no accident that they named it *P. ginseng*, or an herb for all ailments, as it has also been utilized to treat kidney, cardiovascular, and reproductive disorders (Potenza et al., 2023). Bioactive constituents of ginseng are polysaccharides, glucosides, phenolic acids, saponins (Ginsenosides), and triterpenoids along with healthy benefiting vitamins and numerous minerals. Ginsenosides (Rb1, Rb2, Rc, Rd, Re, Ro, Ra & minor ginsenosides) is the most active compound and is responsible of its therapeutic effect (Yang et al., 2021).

Growth of estrogen receptor (ER)-positive (B) cells in vitro can be stimulated by ginseng. Elevated estrogen receptor activity can be induced by ginsenosides Rb1 and Rg1. Thus, while inhibiting follicular stimulating hormone (FSH) and luteinizing hormone (LH), this can markedly raise serum estradiol. When it comes to increasing the fertility rate of PCOS anovulation patients, a notable reduction in plasma luteinizing hormone LH levels may be advantageous and helpful. Additionally, ginseng can aid with sleeplessness, anxiety, and despair that are common after menopause. The reversal of atrophy of the vagina and the uterus with the upregulated expressions of ER-alpha and ER-beta in the productive tissues, along with its ability to modify the estrus cycle and demonstration of strong estrogenic effects, are reasons that ginseng can be used as a natural estrogen replacement therapy (Lakshmi et al., 2023).

Linum usitatissimum

Most commonly known as “Flax” or “Linseed”. This dicotyledonous plant is a species of the Linaceae family. It is a fibrous crop with significant economic worth. This plant is one of the ancient plants and was grown in Egypt and Samaria for 10,000 years and in China and India for 5,000 years ago. Flax also grows in European countries. Flax has been cultivated for fiber and food, as well as ornamental plants because of its bluish flowers. This plant is a great source of fiber and is used in textile industries. Flaxseed is used as food and in medicine because of its rich bioactive components. Its oil, known as “linseed oil”, is edible and has been used commercially in pharmaceuticals. Canada, China, Russia, the United States of America, Kazakhstan and India are significant producers of flax. The biggest exporter of flax is Russia. The noticeable characteristic of flax is that; it can grow even on heavy metal contaminated soil, making it a magnificent candidate for phytoremediation. Flaxseeds are of great nutritional value as it contains a high concentration of short chain omega-3 fatty acids. Flaxseed also has biologically active constituents which can protect from cancer, heart disease, diabetes and strokes (Saleem et al., 2020).

Omega-3 fatty acids, phytoestrogenic-lignans (secoisolariciresinol diglucoside-SDG), sterols, phenols, proteins, flavonoids, glycosides, soluble and insoluble fibres

along with antioxidants, are major constituents of *L. usitatissimum* (Akter et al., 2021). The body's production of estrogen is regulated by the secondary metabolites of flax, which also support menstruation and conception. In a similar vein, they significantly lower increased blood levels of testosterone and also lower androgen levels, both of which are beneficial in treating PCOS. Additionally, flaxseed lessens hirsutism and hyperandrogenism, which are among the major PCOS symptoms. Preclinical research verified that adding flaxseed to the diet promoted the development of the corpus luteum, lowered the number of cysts in ovarian follicles, and decreased testosterone levels in female rats. Therefore, consistent flaxseed consumption through dietary supplementation may considerably reduce ovarian volume and follicle size in the ovaries and help in the regulation of the menstrual cycle (Lakshmi et al., 2023).

CONCLUSION

Today the world is facing a lot of health-related issues. Metabolic and endocrine disorders are getting more common day by day, affecting a large number of populations of every age, from infants to senior citizens. Disturbance in the normal functioning of the body is giving birth to metabolic and endocrine diseases and disorders. These disorders could cause multiple problems in the body at once. Because of the adverse effects of conventional medicines, people are turning towards natural remedies, known as Phytotherapy. Plant made medicines have always been an important part of the Chinese, Unani and Ayurvedic medicine systems. Still, many people rely on traditional medicines for cure and maintenance of health. There is no doubt that plants are full of therapeutic potential as people have been using them as a source of medicines since ancient times. Biologically active compounds in plants have been proven beneficial in curing a number of ailments. These active constituents of plants have the potential of decreasing dyslipidemia which can often lead to heart issues and obesity. Plants such as *C. fructus*, *Mori folium*, *Mangifera indica*, *Tinospora cordifolia*, *Nigella sativa* and *Camellia sinensis* because of their active components proved to be a natural treatment of metabolic disorders, in vitro and in vivo. Being rich in antioxidants, flavonoids, and phenols along with other potent components, plants made themselves a lot safer way of treatment. Hormones are natural chemicals of the body, produced and secreted by glands, which are responsible for carrying out body functions. Their over and under-production can lead to endocrine disorders. Hypothyroidism and PCOS are affecting more people, especially females. And this can cause serious issues if left untreated. Holy plants such as ashwagandha, insulin plant and guggulu can be used as an effective and natural remedy for hypothyroidism. As they have been proven to increase the production of thyroid hormones which is usually compromised in the disorder. PCOS is a complex disorder as it is a cluster of different problems. Plants, like turmeric, ginseng and flaxseeds have the potential to manage the disorder and these plants have been worshiped by old folk because of their extreme benefits. Along with being a source of food, plants have been a great source of treatment and have been used by people in history which dates back up to 10,000 years. This proves that plants should not be overlooked when it comes to cures. Because of a lack of

clinical pieces of evidence, plant medicines are not easily available to people. So, more research and clinical trials should be done in order to bring plant medicine over conventional medicines.

REFERENCES

- Ahmad MF, FA Ahmad, SA Ashraf et al., 2021. An updated knowledge of black seed (*Nigella Sativa* Linn). A review of phytochemical constituents and pharmacological properties. *Journal of Herbal Medicine* 25:100404. <https://doi.org/10.1016/j.hermed.2020.100404>
- Akter Y, M Junaid, SS Afrose et al., 2021. A comprehensive review on *Linum usitatissimum* medicinal plant: its phytochemistry, pharmacology, and ethnomedicinal uses. *Mini Reviews in Medicinal Chemistry* 21:2801-34. <https://doi.org/10.2174/1389557521666210203153436>
- Al Zarzour RH, EE Kamarulzaman, FG Saqallah et al., 2022. Medicinal plants' proposed nanocomposites for the management of endocrine disorders. *Heliyon* 8:e10665. <https://doi.org/10.1016/j.heliyon.2022.e10665>
- Barnes RC, H Kim, C Fang et al., 2020. Body mass index as a determinant of systemic exposure to gallotannin metabolites during 6-week consumption of mango (*Mangifera indica* L.) and modulation of intestinal Microbiota in lean and obese individuals. *Molecular Nutrition & Food Research* 63:800512. <https://doi.org/10.1002/mnfr.201800512>
- Chaker L, SRazvi, IM Bensenor et al., 2022. Hypothyroidism (primer). *Nature Reviews: Disease Primers* 8:30. <https://doi.org/10.1038/s41572-022-00357-7>
- Cui M, L Cheng, Z Zhou et al., 2024. A comprehensive review on traditional uses, phytochemistry, pharmacology, and safety concerns of hawthorn. *Journal of Ethnopharmacology* 319:117229. <https://doi.org/10.1016/j.jep.2023.117229>
- de Miranda JF, LF Ruiz, CB Silva et al., 2022. A review of substrates, regulations, composition, and biological properties. *Journal of Food Science* 87:503-27. <https://doi.org/10.1111/1750-3841.16029>
- de Oliveira Zanuso B, ARDO Dos Santos, VFB Miola et al., 2022. Panax ginseng and aging related disorders: A systematic review. *Experimental Gerontology* 161:111731. <https://doi.org/10.1016/j.exger.2022.111731>
- Devi P, 2021. An updated review on role of *Tinospora cordifolia* in metabolic health disorders. *Himalayan Journal of Health Sciences* 15:15-23. <https://doi.org/10.22270/hjhs.v6i1.91>
- Dhong JQ, JP Chen, SX Gong et al., 2021. Research progress on chemical constituents and pharmacological effects of *Crataegi Fructus* and predictive analysis on Q-Marker. *Chinese Traditional Herbal Drugs* 52:2801-18.
- Emamat H, SH Mousavi, J Kargar Shouraki et al., 2022. The effect of *Nigella sativa* oil on vascular dysfunction assessed by flow-mediated dilation and vascular-related biomarkers in subject with cardiovascular disease risk factors: A randomized controlled trial. *Phytotherapy Research* 36:2236-45. <https://doi.org/10.1002/ptr.7441>
- Eraj A, S Sarfaraz, R Munawwar et al., 2020. Evaluation of hepatoprotective effects of *Commiphora mukul*. *Evaluation* 37:91-7.
- Esharkawy ER, F Almalki & TB Hadda, 2022. In Vitro potential antiviral Sars-Cov-19-activity of natural product thymoquinone and dithymoquinone from *Nigella Sativa*. *Bioorganic Chemistry* 120:105587. <https://doi.org/10.1016/j.bioorg.2021.105587>
- Feldman F, M Koudoufio, Y Desjardins et al., 2021. Efficacy of polyphenols in the management of dyslipidemia. A focus on clinical studies. *Nutrients* 13:672. <https://doi.org/10.3390/nu13020672>
- Ference BA, JJ Kastelein & AL Catapano 2020. Lipids and lipoproteins. *The Journal of American Medical Association* 324:595-6. <https://doi.org/10.1001/jama.2020.5685>
- Ferri FF, 2020. *Ferri's Clinical Advisor 2021 E-Book: 5 Books in 1*. Elsevier Health Sciences.
- Gao XJ, SY Luo, KJ Tang et al., 2021 Effect of crude hawthorn glycoprotein on hypolipidemic and antioxidant activity in high-fat mice. 47:138-142.
- Garang Z, Q Feng, R Luo et al., 2023. *Commiphora mukul* (Hook. ex Stocks) Engl.: Historical records, application rules, phytochemistry, pharmacology, clinical research, and adverse reaction. *Journal of Ethnopharmacology* 317:116717. <https://doi.org/10.1016/j.jep.2023.116717>
- Ghoreyshi M, M Mahmoudabady, S Bafadam et al., 2020. The protective effects of pharmacologic postconditioning of hydroalcoholic extract of *Nigella sativa* on functional activities and oxidative stress injury during ischemia-reperfusion in isolated rat heart. *Cardiovascular Toxicology* 20:130-8. <https://doi.org/10.1007/s12012-019-09540-x>
- Graulich E, 2024. Decoding the endocrine system, a few glands at a time. *Nursing Made Incredibly Easy* 22:14-22. <https://doi.org/10.1097/nme.0000000000000045>

- He L, W Zhou, C Wang et al., 2019. Effect of cellulase and Lactobacillus casein on ensiling characteristics, chemical composition, antioxidant activity, and digestibility of mulberry leaf silage. *Journal of Dairy Science* 102:9919-31. <https://doi.org/10.3168/jds.2019-16468>
- He Z, E Kwek, W Hao et al., 2021. Hawthorn fruit extract reduced trimethylamine-N-oxide (TMAO)-exacerbated atherogenesis in mice via anti-inflammation and anti-oxidation. *Nutrition & Metabolism* 18:6. <https://doi.org/10.1186/s12986-020-00535-y>
- Hoeger KM, A Dokras & T Piltonen, 2021. Update on PCOS: consequences, challenges, and guiding treatment. *The Journal of Clinical Endocrinology & Metabolism* 106:e1071-e1083. <https://doi.org/10.1210/clinem/dgaa839>
- Hu Y, J Xu, Q Chen et al., 2020. Regulation effects of total flavonoids in *Morus alba* L. on hepatic cholesterol disorders in porotic acid induced NAFLD rats. *BioMed Central Complementary Medicine and Therapies* 20:257. <https://doi.org/10.1186/s12906-020-03052-w>
- Ibanez B, A Fernández-Ortiz, L Fernández-Friera et al., 2021. Progression of early subclinical atherosclerosis study. *Journal of the American College of Cardiology* 78:156-79. <https://doi.org/10.1016/j.jacc.2021.05.011>
- Iweala EJ, ME Uche, ED Dike et al., 2023. Curcuma longa (Turmeric): Ethnomedicinal uses, phytochemistry, pharmacological activities and toxicity profiles-A review. *Pharmacological Research-Modern Chinese Medicine* 6:100222. <https://doi.org/10.1016/j.prmcm.2023.100222>
- Jiang H, M Zhang, D Wang et al., 2020. Analytical strategy coupled to chemometrics differentiate *Camellia sinensis* tea types based on phenolic composition, alkaloids, and amino acids. *Journal of Food Science* 85:3253-63. <https://doi.org/10.1111/1750-3841.15390>
- Jyotirmayee B & G Mahalik, 2022. A review on selected pharmacological activities of Curcuma longa L. *International Journal of Food Properties* 25:1377-98. <https://doi.org/10.1080/10942912.2022.2082464>
- Keller A & TC Wallace 2021. An umbrella review of tea intake and cardiovascular disease. *Annual of Medicine* 53:929-44. <https://doi.org/10.1080/07853890.2021.1933164>
- Kumaraswamy A, S Gurunagarjan & B Pemiah, et al., 2020. Scientific evaluation of anti-obesity potential of aqueous seed kernel extract of *Mangifera indica* Linn. in high fat diet induced obese rats. *Obese* 19:100264 <https://doi.org/10.1016/j.obmed.2020.100264>
- Lakshmi JN, AN Babu, SM Kiran et al., 2023. Herbs as a source for the treatment of polycystic ovarian syndrome. A systematic review. *Journal on Biotechnology* 12:4. <https://doi.org/10.3390/biotech12010004>
- Lee E, MS Lee, E Chang et al., 2021. High hydrostatic pressure extract of mulberry leaves ameliorates hypercholesterolemia via modulating hepatic microRNA-33 expression and AMPK activity in high cholesterol diet fed rats. *Food & Nutrition Research* 65:75-87. <https://doi.org/10.29219/fnr.v65.7587>
- Liao S, X Long, Y Zou et al., 2021. Mulberry leaf phenolics and fiber exert anti-obesity through the gut microbiota-host metabolism pathway. *Journal of Food Science* 86:1432-47. <https://doi.org/10.1111/1750-3841.15679>
- Luca SV, I Macovei, A Bujor et al., 2020. Bioactivity of dietary polyphenols. The role of metabolites. *Critical Reviews in Food Science and Nutrition* 60:626-59. <https://doi.org/10.1080/10408398.2018.1546669>
- Maideen NMP, 2020. Prophetic medicine-Nigella sativa (black cumin seeds) - potential herb for covid-19. *Journal of Pharmacopuncture* 23:62-70. <https://doi.org/10.3831/KPI.2020.23.010>
- Malik J & SC Mandal, 2024. Commiphora spp.(Guggul): A Wonder Ayurvedic Drug. *Advances in Medicinal and Aromatic Plants: Production, Processing, and Pharmaceutics* 2:261. <https://doi.org/10.1201/9781032686905-6>
- Mandar BK, P Khanal, BM Patil et al., 2021. In silico analysis of phytoconstituents from *Tinospora cordifolia* with targets related to diabetes and obesity. *In Silico Pharmacology* 9:3. <https://doi.org/10.1007/s40203-020-00063-w>
- Mandlik DS & AG Namdeo, 2021. Pharmacological evaluation of Ashwagandha highlighting its healthcare claims, safety, and toxicity aspects. *Journal of Dietary Supplements* 18:183-226. <https://doi.org/10.1080/19390211.2020.1741484>
- Meng Q, X Qi, Y Fu et al., 2020. Flavonoids extracted from mulberry (*Morus alba* L.) leaf improve skeletal muscle mitochondrial function by activating AMPK in type 2 diabetes. *Journal of Ethnopharmacology* 248:112326. <https://doi.org/10.1016/j.jep.2019.112326>
- Mikulska, P, M Malinowska, M Ignacyk et al., 2023. Ashwagandha (*Withania somnifera*)-Current research on the health-promoting activities: a narrative review. *Pharmaceutics* 15:1057. <https://doi.org/10.3390/pharmaceutics15041057>
- Mirza B, CR Croley, M Ahmad et al., 2020. Mango (*Mangifera indica* L.) A magnificent plant with cancer preventive and anticancer therapeutic potential. *Critical Reviews in Food Science and Nutrition* 61:2125-51. <https://doi.org/10.1080/10408398.2020.1771678>
- Niewiadomska J, A Gajek-Marecka, J Gajek et al., 2022. Biological potential of polyphenols in the context of metabolic syndrome. An analysis of studies on animal models. *Biology* 11:559. <https://doi.org/10.3390/biology11040559>
- Opoku-Acheampong AA, RR Rosenkranz, K Adhikari et al 2021. A systematic review of tools for assessing cardiovascular disease risk factors in underserved young adult populations. *International Journal of Environmental Research and Public Health* 18:13305. <https://doi.org/10.3390/ijerph182413305>
- Pachiappan S, K Ramalingam & A Balasubramanian, 2020. A review on phytomedicine and their mechanism of action on PCOS. *International Journal of Current Research and Review* 12:81. <https://doi.org/10.31782/IJCRR.2020.122322>
- Potenza MA, M Montagnani, L Santacroce et al., 2023. Ancient herbal therapy: A brief history of Panax ginseng. *Journal of Ginseng Research* 47:359-65. <https://doi.org/10.1016/j.jgr.2022.03.004>
- Qi J, J Yang, QZ Wang et al., 2020. Effect of Nippon Hawthorn and Chinese Hawthorn extract on human endogenous amylase activity. *Journal of Food Science and Technology* 38:80-7.
- Rahim MA, A Shoukat, W Khalid et al., 2022. A narrative review on various oil extraction methods, encapsulation processes, fatty acid profiles, oxidative stability, and medicinal properties of black seed (*Nigella Sativa*). *Foods* 11:2826. <https://doi.org/10.3390/foods11182826>
- Razmpoosh E, F Mirzavandi, N Sadeghi et al., 2022. The effect of *Nigella Sativa* on cardio-metabolic parameters. A protocol for a systematic review and meta-analysis. *Journal of Nutrition and Food Security* 7:248-55. <https://doi.org/10.18502/jnfs.v7i2.9339>
- Razmpoosh E, S Safi, A Nadjarzadeh et al., 2021. The effect of *Nigella sativa* supplementation on cardiovascular risk factors in obese and overweight women: a crossover, double-blind, placebo-controlled randomized clinical trial. *European Journal of Nutrition* 60:1863-74. <https://doi.org/10.1007/s00394-020-02374-2>
- Saadat S, MR Aslani, V Ghorani et al., 2021. A comprehensive and updated review on the effects of *Nigella Sativa* on respiratory, allergic and immunologic disorders, evidence from experimental and clinical studies. *Phytotherapy Research* 35:2968-96. <https://doi.org/10.1002/ptr.7003>
- Samanta S, 2022. Potential Bioactive Components and Health Promotional Benefits of Tea (*Camellia sinensis*). *Journal of the American Nutrition Association* 4:65-93. <https://doi.org/10.1080/07315724.2020.1827082>
- Selvakumarasamy S, B Rengaraju, SA Arumugam et al., 2021. *Costus pictus*-transition from a medicinal plant to functional food: A review. *Future Foods* 4:100068. <https://doi.org/10.1016/j.fufo.2021.100068>
- Shah A, 2023. Clinical study to evaluate the efficacy of *Commiphora mukul* (Muqil) on thyroid function in hypothyroidism. *International Journal of Community Medicine and Public Health* 10:3257. <https://doi.org/10.18203/2394-6040.ijcmph20232687>
- Shaiikh AS, AB Thomas & SS Chitlange, 2020. A narrative review of preclinical and clinical studies. Herb-drug interaction studies of herbs used in treatment of cardiovascular disorders. *Phytotherapy Research* 34:1008-26. <https://doi.org/10.1002/ptr.6585>
- Shang A, J Li, D Zhou et al., 2021. Molecular mechanisms underlying health benefits of tea compounds. *Free Radical Biology and Medicine* 172:181-200. <https://doi.org/10.1016/j.freeradbiomed.2021.06.006>
- Sharma R & PK Prajapati, 2020. Predictive, Preventive and Personalized Medicine. Leads from Ayurvedic Concept of Prakriti (Human Constitution). *Current Pharmacology Reports* 6:441-50. <https://doi.org/10.1007/s40495-020-00244-3>
- Sharma R, N Martins & Telomeres, 2020. DNA damage and ageing. Potential leads from Ayurvedic Rasayana (anti-ageing) drugs. *Journal of Clinical Medicine* 9:2544. <https://doi.org/10.3390/jcm9082544>
- Sharma R, N Martins, A Chaudhary et al., 2020. Adjunct use of honey in diabetes mellitus. A consensus or conundrum. *Trends in Food Science & Technology* 106:254-74. <https://doi.org/10.1016/j.tifs.2020.10.020>
- Shinde S, AK Balasubramaniam, V Mulay et al., 2023. Recent Advancements in Extraction Techniques of Ashwagandha (*Withania somnifera*) with Insights on Phytochemicals, Structural Significance, Pharmacology, and Current Trends in Food Applications. *American Chemical Society Omega* 8:40982-41003. <https://doi.org/10.1021/acsomega.3c03491>
- Shirokar A, A Yadav, TK Mandal et al., 2020. Intervention of Ayurvedic drug *Tinospora cordifolia* attenuates the metabolic alterations in hypertriglyceridemia: a pilot clinical trial. *Journal of Diabetes and Metabolic Disorders* 19:1367-79. <https://doi.org/10.1007/s40200-020-00657-3>

- Shoaei-Hagh P, F Kamelan Kafi, S Najafi et al., 2021. A randomized, double-blind, placebo-controlled, clinical trial to evaluate the benefits of *Nigella sativa* seeds oil in reducing cardiovascular risks in hypertensive patients. *Phytotherapy Research* 35:4388-4400. <https://doi.org/10.1002/ptr.7140>
- Singh H, AK Sharma, M Gupta et al., 2020. *Tinospora cordifolia* attenuates high fat diet-induced obesity and associated hepatic and renal dysfunctions in rats. *Pharma Nutrition* 13:100189. <https://doi.org/10.1016/j.phanu.2020.100189>
- Singh H, P Bajaj, S Kalotra et al., 2021. *Tinospora cordifolia* ameliorates brain functions impairments associated with high fat diet induced obesity. *Neurochemistry international* 143:104937. <https://doi.org/10.1016/j.neuint.2020.104937>
- Stevens D, D Alane, SL Harrison et al., 2021. A methodological review of modelling of longitudinal data to predict cardiovascular disease risk. *BioMed Central Medical research methodology* 21:283. <https://doi.org/10.1186/s12874-021-01472-x>
- Sunita S, V Kalsi, HM Mukhtar et al., 2023. Medicinal properties and health benefits of guggul-*Commiphora mukul*. In: American Institute of Physics Conference Proceedings. AIP Publishing 2800: 020158. <https://doi.org/10.1063/5.0167758>
- Tchang BG, MS Tarazi, M Aras et al., 2021. An update on pharmacotherapeutic strategies for obesity. *Expert Opinion on Pharmacotherapy* 22:1305-18. <https://doi.org/10.1080/14656566.2021.1888927>
- Wiciński M, A Fajkiel-Madajczyk, Z Kurant et al., 2023. Can Ashwagandha Benefit the Endocrine System, A Review. *International Journal of Molecular Sciences* 24:16513. <https://doi.org/10.3390/ijms242216513>
- Wilson SA, LA Stem & RD Bruehlman, 2021. Hypothyroidism: Diagnosis and treatment. *American Family Physician* 103:605-13.
- Witchel SF, HJ Teede & AS Peña, 2020. Curtailing pcos. *Pediatric Research* 87:353-61. <https://doi.org/10.1038/s41390-019-0615-1>
- Wu M, L Liu, Y Xing et al., 2020. A review on roles and mechanisms of Hawthorn and its extracts on atherosclerosis. *Frontiers in Pharmacology* 11:118. <https://doi.org/10.3389/fphar.2020.00118>
- Xia X, X Wang, H Wang et al., 2021. Ameliorative effect of white tea from 50-year-old tree of *Camellia sinensis* L. (Theaceae) on kidney damage in diabetic mice via SIRT1/AMPK pathway. *Journal of Ethnopharmacology* 272:113919. <https://doi.org/10.1016/j.jep.2021.113919>
- Xu XY, CN Zhao, SY Cao et al., 2020. An updated review on effects and mechanisms of tea for the prevention and management of cancers. *Critical Reviews in Food Science and Nutrition* 60:1693-1705. <https://doi.org/10.1080/10408398.2019.1588223>
- Yang Y, Z Ju, Y Yang et al., 2021. Phytochemical analysis of *Panax* species: a review. *Journal of Ginseng Research* 45:1-21. <https://doi.org/10.1016/j.jgr.2019.12.009>
- Zhang J, R Yang, YC Li et al., 2021. The role of soil mineral multi-elements in improving the geographical origin discrimination of tea (*Camellia sinensis*). *Biological Trace Element Research* 199:4330-41. <https://doi.org/10.1007/s12011-020-02527-8>
- Zhang R, Q Zhang, S Zhu et al., 2022. A review of its potential influences in mechanisms of action on metabolic diseases of Mulberry leaf (*Morus alba* L.). *Pharmacology Research* 175:106029. <https://doi.org/10.1016/j.phrs.2021.106029>