



Understanding the Anti-Hypertensive Potentials of Natural Resources

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ABSTRACT

Hypertension is a major health problem that may progress to additional heart and circulatory problems. The two most frequent types of hypertension are primary or essential hypertension and secondary hypertension. Hypertension is a prevalent component of coronary heart disease, stroke, and renal vascular disease. Herbal remedies have been used for millions of years to treat and cure hypertension with fewer adverse effects. The overall purpose of this study is to collect data on the anti-hypertensive advantages of natural herbs in animal research and human involvement, as well as to recreate the underlying mechanisms, beginning with cell culture and *ex vivo* tissue data. According to the World Health Organization, natural herbs/shrubs are increasingly being used to treat almost all human ailments (WHO). Plants are used as immune boosters to increase the body's natural capacity to tackle numerous health concerns, as well as herbal drugs and diet. Natural plant treatments are used by 80 percent of the world's population (about 5.6 billion people) for significant health conditions. The historic use, phytochemical components, and pharmacological qualities of medicinal plants used to regulate hypertension are the topic of this research.

Key Words: Anti-hypertensive, Blood pressure, Hypertension, Hypotensive, Natural, Herbal medicines

INTRODUCTION

Hypertension is a serious medical disorder that may jeopardise the health of your heart, brain, kidneys, and other organs. In poor nations, it is the primary cause of death. Despite the fact that a range of modern drugs are used to treat clinical hypertension, they all have side effects. Natural herbal drugs with possible anti-hypertensive activity and fewer side effects may be a beneficial alternative to synthetic pharmaceuticals when accompanied with a change in lifestyle and moderate exercise. Blood pressure is the force exerted by blood against the arterial walls (BP). The two types of blood pressure are systolic blood pressure (SBP) of 120 mmHg and diastolic blood pressure (DBP) of 80 mmHg. In hypertension patients, SBP increases beyond 140 mmHg, whereas DBP rises above 90 mmHg. Hypertension affects 26.4 percent of the world's population, with a 60 percent increase anticipated by 2025 [1]. Hypertension is mainly of two types:

- Patients with primary or essential hypertension (90–95 percent) have no apparent identified reason for an increase in blood pressure.

- Secondary hypertension (5–10 percent), patients' high blood pressure is caused mostly by renal or adrenal illness. Other factors that play a role in hypertension include nitric oxide (NO), cardiac output, and peripheral vascular resistance [2].

The overall purpose of this study is to collect data on the anti-hypertensive advantages of natural herbs in animal research and human involvement, as well as to recreate the underlying mechanisms, beginning with cell culture and *ex vivo* tissue data. According to the World Health Organization, natural herbs/plants are increasingly being used to treat almost all human body issues (WHO). The phytochemical elements in any natural plant make it effective in treating a specific condition or set of symptoms [3]. Medicinal herb/shrub therapy is required and less costly than allopathic treatment, with fewer side effects. Hypertension is a major health problem that may progress to additional heart and circulatory problems. Diuretics are often used to control high blood pressure by lowering blood volume at the price of dangerous and undesired side effects, either alone or in conjunction with other anti-hypertensive medicines.

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Surprisingly, employing natural-source drugs as alternatives is the most effective way to treat hypertension and other related disorders [4]. Plants are common industrial units for the production of chemical components; they are also used as an immune booster to increase the body's natural capacity to fight diseases, as well as herbal treatments and food. In cultural, religious, and traditional traditions, herbal plants are presented as medicinal treatments for almost all ailments. Since 1970, WHO standards have included native plant treatments, mostly for poorer countries. According to recent statistics from numerous international organizations, natural plant treatments are used by 80 percent of the world's population (about 5.6 billion people) for important health conditions [5]. The historic use, phytochemical components, and pharmacological qualities of medicinal plants used to regulate hypertension are the topic of this research.

BLOOD PRESSURE REGULATION

A lot of elements in the cardiovascular system influence blood pressure, including cardiac output, blood volume,

arterial tone balance, and so on. The natriuretic peptides, renin-angiotensin-aldosterone system (RAAS), endothelial cells, immunological system, and sympathetic nervous system (SNS) are all involved in keeping blood pressure in a healthy range. Any imbalance in the components of this neurohumoral system may cause an increase or decrease in average blood pressure, either indirectly or directly [6]. Furthermore, if this imbalance continues for a long time, it may affect the target organ (e.g., chronic renal disease and left ventricular hypertrophy) as well as induce cardiovascular disease. Vascular tone is influenced by potassium channels, NO, the RAAS, reactive oxygen species (ROS), and Ca^{2+} , and any imbalance in these components may lead to hypertension. A variety of lead compounds capable of influencing these characteristics have been created or inspired by nature [7]. **Table 1** summarizes the results of key critical clinical studies done to investigate the antihypertensive effects of various natural resources.

Table 1: Clinical trials of the different medicinal plants as anti-hypertensive resources.

PLANTS	DOSAGE	DURATION	CONDITION	DESIGN
<i>Allium sativum</i>	2600 mg/day	10 days	Mild hypertension	Placebo-controlled, crossover
<i>Camellia sinensis</i>	7.6 g /hour	12 weeks	Mild hypertension	Double-blind, placebo controlled
<i>Crataegus spp.</i>	500 mg/day	10 weeks	Mild hypertension	Double-blind, randomized, parallel, placebo-controlled
<i>Crocus sativus</i>	400 mg/day	1 week	Healthy	Double-blind, randomized, parallel, placebo-controlled
<i>Hibiscus sabdariffa</i>	10 g/day	4 weeks	Mild to Moderate hypertension	Randomized, captopril- controlled
<i>Nigella sativa</i>	400 mg/day	8 weeks	Mild hypertension	Randomized, double-blind, placebo-controlled
<i>Panax ginseng</i>	3 g/day	12 weeks	Essential hypertension	Randomized, double-blind, placebo-controlled/

NATURAL RESOURCES AS ANTI-HYPERTENSIVE RESOURCES

***Allium sativum* (Common Name: Garlic; Family: Amaryllidaceae)**

Because of its strong taste and scent, the bulb of *Allium sativum* has been used as a vegetable for thousands of years. It might be utilized to treat cardiovascular diseases such coronary heart disease, hypertension, atherosclerosis, and aging-related vascular changes. Anti-cancer, anti-inflammatory, anti-microbial, and hypocholesterolemic characteristics are also found in it. All of these pharmacological activities will fascinate pharmacologists and health practitioners.

Organosulfur components such as allicin (the major active ingredient), ajoene, S-allyl-L-cysteine, diallyl disulfides (DADS), methyl thiosulfonate, and diallyl trisulfides, among others, are thought to be responsible for these pharmacological effects. Raw, dry powder, aqueous extract, oil, and aged garlic extract are all available forms of *A. sativum* (AGE). When AGE was compared to other types of *A. sativum*, meta-analytic interpretation revealed that it consistently lowers blood pressure (both SBP and DBP). Garlic's ethanolic extract was shown to enhance relaxation in rat pulmonary arteries by increasing NO bioavailability through sulfide components like allicin. Garlic is claimed to

provide polysulfides to red blood cells, causing an increase in H₂S production and synthesis and so vasorelaxation. Furthermore, gamma-glutamyl-cysteines, a component of garlic, were revealed to function as an antagonist to inhibit ACE activity. When Allicin reacts with the Alliinase enzyme, it antagonizes the endothelin-1 action, reduces Ang-II vasoconstrictor responses, and deactivates NF- κ B [8].

***Andrographis paniculata* (Common Name: Kalmegh, Kirayat, Bhunimba, King of Bitter; Family: Acanthaceae)**

Colds, fevers, upper respiratory and gastrointestinal tract infections, hepatitis, herpes, and cardiovascular disease are all treated with this ancient Asian medicinal plant. β -adrenoceptors, autonomic ganglion receptors, and angiotensin-converting enzyme (ACE) activity are all inhibited by *Andrographis paniculata*. 14-deoxy-11,12-didehydroandrographolide, andrographolide, and 14-deoxyandrographolide are anti-inflammatory, anti-bacterial, anti-oxidant, and hypotensive diterpenoid compounds found in its extracts. Its chloroform extract may enhance NO generation in endothelial cells, resulting in smooth muscle relaxation by inhibiting ACh action. *A. paniculata* reduces blood pressure in impulsively hypertensive rats via reducing ROS and ACE activity (SHR). Both 14-deoxyandrographolide and 14-deoxy-11,12-didehydroandrographolide reduced vascular resistance in isolated rat hearts, according to recent research. According to the researchers, a crude extract with a high concentration of 14-deoxy-11,12-didehydroandrographolide has a considerable hypotensive impact owing to increased NO release, which induces vasodilation. In addition, 14-deoxy-11,12-didehydroandrographolide blocks voltage-gated Ca²⁺ channels, reducing Ca²⁺ levels in the cell. The chloroform extract, which inhibited the L-type Ca²⁺ current and high K⁺ activation pathways, produced endothelial protective effects to relax the smooth muscle, and the results were comparable to verapamil [9].

***Apium graveolens* (Celery) (Common Name: Celery, Ajmod; Family: Apiaceae)**

Any early or perennial plant occurring in the subtropical and temperate areas of Asia and Africa. Different components of *Apium graveolens* are used to generate various therapeutic formulations because of their anti-inflammatory, anti-hypertensive, anti-microbial, bactericidal, fungicidal, anti-cancer, anti-virus, gastro-intestinal, anti-spasmodic, and anti-oxidant properties. *In vivo* animal tests, *A. graveolens* has been demonstrated to have a hypotensive effect. Seed extracts in hexane reduce blood pressure in hypertensive rats more effectively than other extracts. This is owing to a higher level of *n*-butylphthalide preservation, which is responsible for the taste and fragrance of celery. The activity of *n*-butylphthalide was likewise validated by SHRs. By restricting Ca²⁺ influx and hence blocking voltage and

receptor gated channels, apigenin flavone extracts decrease aortic ring contractions in isolated rat aortas. The active components of celery lower human blood pressure via reducing vascular resistance and decreasing the intensity of circulating catecholamines. BP may be reduced by 12% by taking seed extract on a regular basis for four weeks. This plant's flavonoid content reduces oxidative stress, perhaps increasing anti-oxidant mechanisms. Because of hydrophobic components like *n*-butylphthalide, celery seeds have a hypotensive impact (NBP). It may also be utilized to treat hypertension caused by the liver [10].

***Bidens pilosa* (Common Names: Broom Stick, Beggar's stick and Black-Jack; Family Asteraceae)**

Bidens pilosa is used in folk medicine in a variety of ways, including tincture, dry powder, maceration, and decoction. The bioactive components offer a variety of therapeutic benefits and have been used to treat bacterial, cancer, obesity, hypertension, malaria, and cardiovascular problems, making it a widely used plant today. There are at least 60 flavonoids in *B. pilosa*, and it contains a range of chemical components. As a result, extracts from this plant are often used as a pharmaceutical to treat around 40 different illnesses via diverse processes such as vasodilation, lipid profile improvement, free radical scavenging, insulin sensitivity, calcium blocker, and so on. Quercetin enhances endothelial function by boosting NO production and/or bioavailability, according to previous study. The efficacy of quercetin to decrease and prevent hypertension was validated by the researchers. Methylene chloride and aqueous extracts restored hypertriglyceridemia and high blood pressure produced by fructose consumption, but had little effect on blood glucose or insulin levels, with only a few tests suggesting an effect on insulin sensitivity. Leaf extracts in high doses may reduce plasma creatinine while raising plasma cholesterol levels. As a consequence, they theorized that extracts' hypotensive effect is independent of insulin sensitivity. Researchers discovered that aqueous and CH₂Cl₂ leaf extracts may decrease and prevent high blood pressure in numerous normotensive and hypertensive rat models after a 3-week continuous treatment (caused by fructose). *B. pilosa* produces vasorelaxant responses in noradrenaline and potassium chloride pre-constricted rat aortas, according to researchers, who also discovered that increasing the amount of a neutral chemical extract causes relaxation in noradrenaline and potassium chloride pre-constricted rat aortas. They were unable to come up with a clear mechanism for vasodilation, though. Vasodilation might be mediated by calcium channel antagonism or a cyclooxygenase metabolite, according to their theory. They further claimed that the ATP-dependent K⁺ channel was unrelated to the vasodilation process [11].

***Camelliasinensis* (Common Name: Tea; Family: Theaceae)**

It's brand new, spotless, and bright. Tea, made from *Camellia*

assamica or *Camellia sinensis* leaves, is the world's most popular beverage when mixed with water. (-)-epigallocatechin-3-gallate (ECG), (-)-epigallocatechin-3-gallate (EGCG), (-)-epigallocatechin (EC), (-)-epigallocatechin (EC), (-)-epigallocatechin (EC), (-)-epigallocatechin (EC), (-)-epigallocatechin (EC), (-)-epigallocatechin (EC) (EGC, primary component). As a consequence of an enzymatic process, the catechins are transformed to flavins, and the arubigins are known to be effective vasodilators. Due to increased NO release and a reduction in oxidative stress and dimethylarginine levels, these catechins are also responsible for a considerable increase in blood flow. In addition, EGCG reduced NF- κ B activation in human endothelial cells. Secondary metabolites include purine alkaloids, phenolic acids, flavan-3-ols, flavonols, saponins, hydrolyzable tannins, and condensed tannins, as well as their glycoside forms. New molecules, such as flavan-3-ol derivatives, theaflavins, and thearubigins, emerge when the concentration of other chemical constituents changes. As a consequence, depending on the process, each kind of tea has different tastes and constituents. Anti-diabetic, anti-inflammatory, anti-bacterial, anti-hypertensive, and anti-cancer activities are all found in *C. sinensis* aqueous extract. Those who consume green and black tea on a regular basis are at a low risk of developing hypertension. Tea drinking has been shown to have a considerable decreasing impact on DBP by researchers, while other study has revealed that it is concentration dependent. The usage of concentrated green tea may reduce the risk of death from cardiovascular disease. Daily intake of black tea extract for seven days decreases SBP because the o-methylated EGCG concentration in tea suppresses the ACE. According to the researchers, theaflavin-3,3-digallate may decrease endoplasmic reticulum stress and change enzymes like cystathionine gamma-lyase and cystathionine-synthase, which may diminish acetylcholine-dependent contraction and enhance endothelial function. Ingestion of lyophilized green tea extract resulted in a considerable decrease in SBP (4.9 mmHg) and DBP in moderately hypertensive people (4.7 mmHg). Green tea decreases blood pressure via maintaining a healthy balance of vasoconstricting, vasodilating, and hyperpolarizing hormones, among other things. It increases NO production by stimulating anti-oxidant enzymes and inhibiting pro-oxidant enzymes, which helps to enhance ventricular function and control ROS production [12].

***Coptis chinensis* (Common Name: Chinese Gold Thread; Family: Ranunculaceae)**

It's a common ingredient in traditional Chinese medicine. Berberine (BBR), the major chemical component of *Coptis chinensis*, has sedative, immunostimulatory, hypotensive, antibacterial, choleric, anti-convulsant, uterotonic, anthelmintic, anticancer, and carminative properties. It has an effect on lipid and glucose metabolism, cardiotoxicity,

and endothelial function, among other things. As a result of all of these actions, the alkaloid BBR has become a research issue in the last ten years. According to studies, BBR has a considerable hypotensive effect via a number of mechanisms. BBR boosts the expression of the eNOS enzyme, which is involved in NO synthesis and release as well as vasodilation. The opening of the well-known vasodilators PGI₂ and KATP channels, as well as the suppression of Ca²⁺ influx, may all play a role in this vasodilation. According to one study, BBR induces endothelial dysfunction by delaying endothelium microparticle development. BBR has been shown to inhibit the transcription factors NF- κ B and VCAM-1, as well as VSMC development [13].

***Coriandrum sativum* (Common Name: Kasbour, Coriander, Cilantro; Family: Apiaceae)**

The fruits and leaves of *Coriandrum sativum* and *Coriandrum tordylium* are used in the traditional treatment of gastrointestinal and cardiovascular problems, as well as a catering ingredient. Its oil is used in a wide range of cosmetics. Flatulence, diarrhoea, anorexia, dyspepsia, vomiting, and pain are all treated with *C. sativum*, which also acts as an anti-hypertensive, anti-bacterial, anti-emetic, myorelaxant, anti-diabetic, anti-inflammatory, emmenagogue, lipolytic, and nerve-calming agent. Coriander's primary chemical components are linalool, geranyl acetate, and gamma-terpinene. α -cedrene (3.87 percent), citronellal (1.96 percent), geraniol (1.87 percent), α -pinene (1.82 percent), β -sesquiphellandrene (1.56 percent), citral and citronellyl acetate (1.36 percent), citronellol (1.31 percent), *m*-cymene (1.27 percent), and α -farnesene (1.27 percent) are among the other chemical ingredients (1.22 percent). Although it has been reported in multiple studies that coriander has anti-oxidant qualities and inhibits ROS generation by the β -adrenoceptor, it has not been tested in clinical trials to examine how it affects blood pressure. Dilute methanolic solutions of well-dried seeds and powder of coriander had vasodilatory effects in normotensive Sprague-Dawley rats, and mean arterial blood pressure (MABP), SBP, and DBP dropped in a dose-dependent manner. The vasodilator effect is produced via blocking Ca²⁺ channels and endothelial-dependent pathways. The active ingredients work together to balance vasoactive components in the management and treatment of hypertension. NF- κ B and iNOS expression are also inhibited by coriander extract [14].

***Crataegus* spp. (Genus: *Crataegus crenulata*, *Pyracanthacrenulata*; Common Name: Hawthorns, Hawberry or Thorn Apple; Family: Roseaceae)**

Hawthorn plants have been used in traditional medicine to treat cardiovascular ailments for a long time. The Hawthorns medicine (500 mg daily for 10 weeks) helps hypertensive people decrease their blood pressure. A considerable drop in blood pressure occurs only after delivering the drug

in higher doses over a longer length of time. In a random, placebo-controlled, double-blind clinical trial including the administration of *Crataegus curvisepala* hydro-alcoholic extracts of flowers for three months, DBP and SBP both reduced by around 8 and 13 mmHg, respectively. The principal chemical element in *Crataegus tanacetifolia* is quercetin, a polyphenolic flavonoid that is responsible for the plant's key pharmacological properties, which include vasorelaxant, anti-inflammatory, and anti-oxidant effects. These plants also include oligomeric proanthocyanidins including procyanidin, procyanidin B₂, hyperoside, and flavonoids such as vitexin, rutin, and others. Hawthorn extracts are also effective on endothelial cells as well as VSMCs. The extract of *Crataegus tanacetifolia* promotes vasodilation in endothelial cells by boosting eNOS phosphorylation and activation at serine1177, which increases NO generation and release. *Crataegus hyperoside* may activate a variety of signaling pathways, including PI3-kinase, eNOS, Src, ROS, Akt, and anti-oxidant enzymes (CAT, SOD, and others), resulting in endothelium-dependent relaxation. When all of *Crataegus*' mechanisms of action operate together, the hypertension outcome improves. VCAM-1, IL-6, NF-kB, iNOS, and TNF- α are all reduced in the extract, which has an anti-inflammatory impact [15].

***Crocus sativus* (Common Name: Saffron; Family: Iridaceae)**

The stemless plant *Crocus sativus* has been utilized for medicinal reasons for over 4000 years. It's used to provide taste and color to a variety of foods, as well as in cosmetics. Chemical constituents include flavonols (kaempferol), carotenoids (crocin and crocetin), phenolic chemicals, anthocyanins, terpenoids, and alkaloids. Saffron extract was used as an antispasmodic, aphrodisiac, expectorant, anti-depressant, anti-tussive, anti-convulsant, neuroprotective, hypolipidemic, anxiolytic, anti-cancer, cardiovascular protective, and anti-oxidant. The main chemical components are crocin, safranal, picrocrocin, and crocetin. These chemicals function as anti-hypertensives in a number of ways. Saffron's vasorelaxant action has been shown in tests to generate a considerable reduction in arterial pressure and SBP in healthy people when used often for 7 days. The anthocyanins and flavonoids found in the petal extracts of *C. sativus* may change peripheral vascular resistance and, as a consequence, reduce blood pressure in male Sprague-Dawley rats in a quantity-dependent manner. In both normotensive and saline-stimulated hypertension, crocin, safranal, and stigma extract reduce MABP in male Wistar rats. Long-term safranal injections also lowered SBP in salt hypertensive rats but had no impact on normotensive rats, according to research. Saffron's chemical components, especially crocin, decreased guinea pig contraction and heart rate via activating potassium channels, blocking Ca²⁺ channels, and antagonizing β -adrenoceptors. Safranal also impacts protein

kinase GSK-3 phosphorylation, iNOS activation, TNF- α expression, and NF-kB activity [16].

***Cymbopogon citratus* (Common Name: Lemongrass, Citronella, Squinant; Family: Poaceae)**

Because the extract of *Cymbopogon citratus* shoots and leaves has a large amount of essential oil, it is widely used for nutritional, aesthetic, and medicinal applications all over the globe. In various studies, phytoconstituents such as flavonoids, alkaloids, essential oil, phenols, tannins, deoxysugars, saponins, and anthraquinones have been discovered in the plant's leaves and stem. Citral, the primary component of *C. citratus*, has antibacterial, antioxidant, chemoprotective, and antispasmodic properties whether taken alone or in combination with other ingredients. On phenylephrine-stimulated contractions, methanolic extracts of aerial parts (stems and leaves) and roots (containing citral as the main active constituent) demonstrated dose-dependent vasorelaxation. Citral prevents L-NAME from attenuating, causing NO generation and release, resulting in vasorelaxation. Furthermore, the extract from the leaves has the capacity to alter prostacyclin production, resulting in relaxation. The calming effect of the root, stems, and leaves extracts might also be attributable to Ca²⁺ ion channel blockage (endothelium-independent). The fresh leaf extract, when combined with other herbal treatments like *Citrus medica* fruits extracts and *Persea americana* fresh leaf extracts, may help rats with hypertension induced by sugar and ethanol. This combination may be used to protect kidney, liver, and vascular endothelium that has been harmed by sugar and ethanol consumption for a long time. The use of a lemongrass decoction twice a day had a substantial effect on MABP, according to the researchers. Citronellol (acyclic monoterpenoid) inoculated intravenously produced an antihypertensive impact in Wistar rats via blocking calcium channels and altering caffeine-gated and IP3-dependent intracellular Ca²⁺ storage. Lemongrass oil has the ability to block the activity of reactive oxygen species (ROS). Citral suppresses iNOS and NF-kB activity, as well as having anti-inflammatory characteristics [17].

***Hibiscus sabdariffa* (Common Name: Rosella, Hibiscus, Jamaica Sorrel, Red Sorrel; Family: Malvaceae)**

Different components of this plant, such as the flower, leaves, and calyx of *Hibiscus sabdariffa*, are utilised to treat various medicinal problems in numerous West African countries. Because of its enticing taste, decorative appearance, medicinal, and culinary properties, it is used to manufacture a range of current cold and hot drinks. Fresh or prepared salads composed from delicate young leaves, calyx, and stems are presented. In several cultures, the calyx is used to produce soups, pickles, sauces, pudding, and as a flavoring element. Nigerians used calyx infusion (zobo) as an anti-hypertensive treatment. Antibacterial, antioxidant, anti-cholesterol, and

anti-hypertensive properties are all present in the plant. According to residents of Jordan's North Badia area, leaves and flowers are used to treat high blood pressure, while hot aqua infusions are used to treat low blood pressure. The leaves are used to treat hypertension in Tobago and Trinidad, while the bloom and seeds have a hypocholesterolemic effect. After treatment with the extract, SBP and DBP levels in salt-induced hypertension and normotensive subjects fell dose-dependently. When compared to ACE inhibitors, it was equivalent to captopril but less effective than lisinopril. According to various studies, extract of HS calyces has antihypertensive and vasodilator effects in humans and experimental animals through vasodilator pathways that are both dependent and independent of the endothelium. When the cGMP/NO-relaxant route is opened, endothelium-dependent vasodilation is generated by activation of guanylate cyclase, while endothelium-independent vasodilation is caused by blocking of Ca^{2+} inflow. Its water-soluble active components, anthocyanins, especially cyanidin-3-sambubioside and delphinidin-3-sambubioside, have hypocholesterolemic, anti-oxidant, and anti-hypertensive activities [18].

***Nigella sativa* (Common Name: Seed of Blessing, Black Cumin; Family: Ranunculaceae)**

Both aqueous and oily Seed of Blessing extracts have a broad range of pharmacological effects and are used to treat a number of diseases and ailments, including diabetes, inflammation, hypertension, cardiovascular difficulties, hepatic disease, cancer, renal disease, and arthritis. When *Nigella sativa* is taken, blood pressure is reduced. The majority of the positive benefits of seeds are due to thymoquinone, a principal active component in black seed essential oil. *In vivo*, black cumin oil decreases ACE, which has antihypertensive properties. Thymol, the other active component of *N. sativa*, has been demonstrated to reduce blood pressure in endothelium cell membranes by an endothelial-independent mechanism (inhibition of Ca^{2+} influx via calcium channels), followed by vasorelaxation. Black seed oil contains essential oils, flavonoids, anti-oxidants, alkaloids, saponin, proteins, fatty acids, and other bioactive components such as thymol (THY), thymoquinone (TQ), thymohydroquinone (THQ), dithymoquinone (DTQ), and α -hederin, as well as flavonoids, anti-oxidants, alkaloids, saponin, proteins. Investigators discovered that consuming the extract twice daily for eight weeks reduced blood pressure significantly in those with mild hypertension. It inhibits the production of reactive oxygen species (ROS), which may aid in the management of hypertension. Both DBP and SBP may be dramatically reduced by the oil. TQ also induces vasodilation by reducing COX-1 and COX-2 metabolite synthesis and release. Black cumin inhibits the proteins NF- κ B and TNF- α as an anti-inflammatory agent. [19]

***Panax* (*Panax ginseng*, *Panax quinquefolius*, *Panax japonicas*, *Panax notoginseng*; Common Name: Japanese**

Ginseng, Asian or Korean Ginseng, Chinese ginseng, American Ginseng; Family: Araliaceae)

For centuries, the *Panax* ("all healer") was thought to be capable of treating all human illnesses. *Panax* roots, in both solid and liquid form, have long been used in folk medicine for a variety of pharmacological and therapeutic purposes. The 40 ginsenosides found to date include Rb1, Rg1, Rg3, Rh1, Re, and Rd, which are the most active and helpful. Hypotension, anti-oxidant, anti-diabetic, vasorelaxation, anti-carcinogenic, anti-allergic, anti-inflammatory, anti-diabetic, anti-cancer, and so on are some of the biological features of this medicinal plant. Surprisingly, research suggests that ginseng may help to "normalize" hypertension and hypotension. Anti-cancer and anti-diabetic activities are also present. Although it is well known that ginseng reduces blood pressure, scientists believe it may also increase blood pressure to restore hypotensive circumstances rheostatically, most likely by modifying the vascular character, the autonomic nervous system, or the baroreflex of arteries. In both patients with moderate hypertension and healthy individuals, researchers observed that ginsenoside from *Panax ginseng* had a substantial decreasing effect on SBP and DBP. Ginsenoside Rg3 has a stronger effect on eNOS expression, which leads to more NO production and vasorelaxation. Ginseng also inhibits the release of catecholamines from the adrenal glands, lowering blood pressure [20].

***Rauwolfia serpentina* (Common Name: Devil Pepper, Indian Snakeroot, Serpentine Wood; Family: Apocynaceae)**

Rauwolfia serpentina is most often used to treat high blood pressure. It slows the heart rate and dilates the blood vessels by reducing the activity of the nervous system. Indole alkaloids are the most abundant phytochemicals in *R. serpentina*, although it also contains fatty acids, alcohols, sugars and glycosides, steroids, phytosterols, flavonoids, oleoresins, and tannins. The root bark is the major source of indole alkaloids, which may be found in all parts of the plant. The indole derivatives ajmalinine, ajmalidine, ajmalicine, ajmaline, coryanthine, aricine, deserpidine, canescine, lankanescine, isoserine, isoajmaline, isoserpine, rauhimbine, neoajmaline, raubasine, papaverine, and raucafricine have all been discovered. The most common indole derivative, reserpine, is anti-hypertensive, decreasing both systolic and diastolic blood pressure. Reserpine's irreversible binding to VMAT2 depletes biogenic amines such as serotonin, nor-adrenaline, and dopamine in the VTA (ventral tegmental area), hypothalamus, and nucleus accumbens. The VMAT2 protein binds to storage vesicles in the cell permanently, leading them to 'leak' their contents, such as monoamine, into the cytosol, where it is polluted by monoamine oxidase-A (MAO-A) enzymes. According to

this mechanism, monoamine renovation is age-independent [21].

***Salviae miltiorrhizae* (Common Name: Danshen, Red/Chinese Sage; Family: Labiatae)**

One of China's oldest and most often used traditional herbs for the treatment of CVDs is *Salviae miltiorrhizae*. The primary phytochemicals are danshensu, tanshinones (tanshinone-I and tanshinone-II), and salvianolic acids (A and B), with other components being minor. Anti-microbial, anti-viral, anti-oxidant, anti-cancer, anti-inflammatory, and cardiovascular disease-fighting qualities are all found in root extracts. By enhancing eNOS signaling synthesis and magnifying NO production to promote vasodilation, Danshen's roots extract decreases pulse rate and systolic BP in a small manner. Tanshinone-IIA causes vasodilation without needing endothelial cells to participate. Danshen's metabolite increases intracellular Ca^{2+} storage as well as influx via calcium channels that are voltage-dependent and receptor-dependent. Danshen inhibits ACEs as well, resulting in a reduction in blood pressure and anti-hypertensive effects. Other hypertension-related parameters that Danshen affects include ROS production, oxidation, inflammation, and proliferation [22].

***Terminalia arjuna* (Common Name: Arjuna; Family: Combretaceae)**

Terminalia arjuna has long been used as a cardioprotective agent by researchers (induced heat shock protein in the myocardium). Based on decades of experience, the decoction of arjuna bark is used to treat congestive heart failure, dyslipidemia, anginal pain, and hypertension on the Indian subcontinent. Among the various compounds are flavonoids, triterpenoids, -sitosterol, glycosides, arjunetosides I–IV, arjunone, arjunine, arjunolone, saponins, arjunetein, oligomeric proanthocyanidins, leteilin, ellagic acid, phytosterols, gallic acid, arjungenin, arjunic acid, tannins, arjunolic acid, and minerals. Arjuna has prostaglandin E_2 -like actions in myocardial ischemia produced by isoprenaline, such as hypotension and coronary vasodilation. The bark extract may also attenuate isoprenaline-induced oxidative damage. *T. arjuna*'s major advantage is that it increases cardiac muscle activity, which enhances heart pumping function. Saponin glycosides are thought to be responsible for the inotropic effect, whereas OPCs and flavonoids are thought to be responsible for vascular strength and anti-oxidant action. Cardenolides increase intracellular sodium and calcium levels, which enhance cardiac contraction power. It also has diuretic, cardiotonic anti-inflammatory, ROS scavenging, anti-thrombotic, anti-platelet, anti-atherogenic, and hypolipidaemic effects. It may also be used alone or in conjunction with a statin to treat coronary artery disease. Due to its biological characteristics, it has become a one-of-a-kind medicinal plant [23].

***Tribulus terrestris* (Common Name: Gokhru/Gokshura, Puncture Vine; Family: Zygophyllaceae)**

The annual herb *Tribulus terrestris* has long been used to cure a range of ailments. The shrub contains a variety of medicinally important chemical constituents, including saponins (tigogenin, neotigogenin, hecogenin, neohecogenin, gitogenin, neogitogenin, chlorogenin, sarsasapogenin, ruscogenin, and diosgenin), flavonoids, alkaloids, and glycosides, as well as flavonoids, alkaloids, and glyco (quercetin 3-*O*-rutinoside, quercetin 3-*O*-glycoside, and kaempferol 3-*O*-glycoside). These active constituents have been shown to have immunomodulatory, aphrodisiac, anti-urolithic, diuretic, hypolipidemic, anti-diabetic, hepatoprotective, analgesic, absorption enhancing, cardiotonic, anti-inflammatory, anti-bacterial, anti-spasmodic, anti-cancer, anti-cariogenic, larvicidal, and anthelmintic properties. According to Chinese specialists, the *T. terrestris* plant is often used to treat coronary heart disease, cerebral arteriosclerosis, myocardial infarction, thrombosis, and hypertension. Aqueous and methanolic extracts of gokhru exhibit a significant anti-hypertensive action in impulsive hypertensive rats via hyperpolarizing membranes and relaxing arterial smooth muscle. Its ability to boost NO release from nitrergic nerve terminals and endothelium has been reported to be effective in the treatment of a variety of disorders. Gokhru's antihypertensive effects are assumed to be attributed to its ACE inhibitor characteristics [24].

***Zingiber officinale* (Common Name: Ginger; Family: Zingiberaceae)**

Since the thirteenth century, the rhizome of *Zingiber officinale* has been a popular culinary component. Recent research suggests that ginger aqueous extract may reduce ACE and lipid peroxidation. Researchers observed that shogol and gingerol administered intravenously and orally produced in a considerable drop in blood pressure. Ginger oils are clearly a novel antagonist of the vasodilator angiotensin-II type-1 receptor. *Z. officinale* has been used for thousands of years in traditional medicine. Some of the constituents include beta-carotene, gingerdiol, gingerol, gingerdione, caffeic acid, capsaicin, and curcumin. According to a literature review, ginger has biological activities such as blood pressure lowering, cholesterol lowering, anti-oxidant, anti-inflammatory, anti-microbial, anti-cancer, anti-platelet aggregation, hypoglycemic, cardiovascular protective, neuroprotective, respiratory protective, anti-diabetic, chemopreventive, anti-obesity, anti-emetic, and anti-nausea. Ginger's health advantages are mostly due to the presence of phenolic compounds such as shogaol and gingerols. Researchers observed that eating ginger powder every day for 56 days may lower DBP and SBP in people with type-2 diabetes. According to certain studies, ginger may be used

with anti-hypertensive medications to improve the treatment of hypertension [25].

CONCLUSION

Finding a more effective method to treat hypertension and cardiovascular disease, which are the leading causes of death globally, is crucial nowadays. Nature inspired or manufactured all new, small chemical substances supplied as a treatment during the decays. This might be one of the reasons why the majority of patients choose herbal drugs over allopathic pharmaceuticals for CVD treatment. In this research, we discussed the most often used plants for hypertension control and therapy, as well as their modes of action. Endothelial function, ROS production, pro-inflammatory signaling, platelet activation, opening and closing of different ion channels, ACE inhibition, gene expression, and other pharmacological activities of natural plants and their isolates affect hypertension pathogenesis by modulating several parameters such as endothelial function, ROS production, pro-inflammatory signalling, platelet activation, opening and closing of different ion channels, ACE inhibition, gene expression, and other pharmacological activities. Herbal medications will definitely get more attention in the future, since they have a broad spectrum of effectiveness, as determined by clinical and experimental studies. Patients should also be taught how to utilise herbs that have been around for a long time, such black cumin, coriander, garlic, Chinese sage, ginger, and ginseng. Because some drugs on the market have the potential to raise blood pressure and harm individuals.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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The author did the literature survey from standard databases, collected all essential elements, and wrote this manuscript.

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