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A Review on Role of Herbal Medicine in Antihypertensive Drug

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Abstract: *Herbal medicines have long been used worldwide to treat hypertension. In recent decades randomized trials, systematic reviews and mechanistic studies have investigated a number of botanicals showing modest but clinically meaningful reductions in blood pressure for some agents and plausible mechanisms (vasodilation, antioxidant effects, RAAS/ACE modulation, diuresis). Evidence quality is heterogeneous, safety and herb–drug interactions are important concerns, and larger, standardized trials with well-characterized preparations are needed before many herbal products can be recommended as routine antihypertensive therapy. Key clinical and mechanistic findings are summarized below. Some of the most commonly cited herbal medicines for high blood pressure include garlic, hibiscus, ashwagandha, and triphala, which are thought to work through various mechanisms like relaxing blood vessels, reducing stress, and improving cardiovascular function. However, it is crucial to consult a doctor before using any herbal remedies for high blood pressure, as they can interact with medications and may not be suitable for everyone.*

Keywords: Antihypertensive Drug, Herbal Medicine, Herbal Plant

I. INTRODUCTION

Hypertension is a leading global risk factor for cardiovascular disease. Many patients worldwide use herbal medicines either as complementary therapy or in place of conventional drugs. Scientific interest has focused on which botanicals have reproducible BP-lowering effects, how large those effects are, and whether they are safe to combine with standard antihypertensives. This review summarizes current evidence (clinical trials, meta-analyses, and mechanistic studies) for the most studied herbs and highlights clinical implications and research [1]

Hypertension, or high blood pressure, is one of the common health problems worldwide. Its prevalence is high, and it is considered a major risk factor for cardiovascular diseases and other complications.1 According to the World Health Organization, high blood pressure occurs when two consecutive measurements remain ≥140/90 mmHg. Approximately 30% of men and 50% of women aged 65–75 years present with hypertension. Moreover, 1.56 billion people are hypertensive worldwide. This value indicates a 60% increase in the prevalence of hypertension.[2]

Hypertension and atherosclerosis are the major causes behind any cardiovascular diseases. Hypertension has become one of the most medicated but avoidable diseases of the twenty-first century.[3] There are often no symptoms of hypertension, and it can easily go undetected, which is why it is known as the silent killer. The National Institutes of Health classifies hypertension when either systolic blood pressure is greater than 140 mmHg or diastolic blood pressure is greater than 90 mmHg.[4] Numerous factors can increase the risk of developing pertension such as stress, a high salt diet, Family history, increased abdominal fat and drinking excessive amounts of alcohol. Certain chronic conditions also may increase your risk of high blood pressure, Such as kidney disease, diabetes and sleep apnea.[5]

Hypertension is a chronic and often asymptomatic medical condition in which systemic arterial blood pressure is elevated beyond normal. As such, the heart is forced to work harder to overcome the increased systemic pressure in order to deliver blood to tissues, which puts strain on the heart and arteries. Over the period of time, the additional strain leads to cardiovascular dysfunction and is a primary contributing cause of congestive heart failure, myocardial infarction, pulmonary embolism, cerebral aneurysm and kidney failure.[6] There are numerous ways in which it is

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possible for an individual to prevent and manage hypertension such as altering their lifestyle by reducing excess weight, increasing exercise and adopting healthy eating habits.[5]

The first directive from a health professional is generally for the patient to adopt some lifestyle changes before any medication is prescribed. There is, at present, the Dietary Approaches to Stop Hypertension (DASH) diet that has been recommended by healthcare professionals as an approach to lower the risk of hypertension, and focuses not only on the importance of reducing salt intake but also on limiting dietary intake of saturated fat, cholesterol and total fat. It advocates a diet high in vitamins and minerals, fruit and vegetables, fat-free and low fat dairy, lean meats and poultry, and the inclusion of nuts, seeds and legumes.[7]

PATHOPHYSIOLOGY OF HYPERTENSION

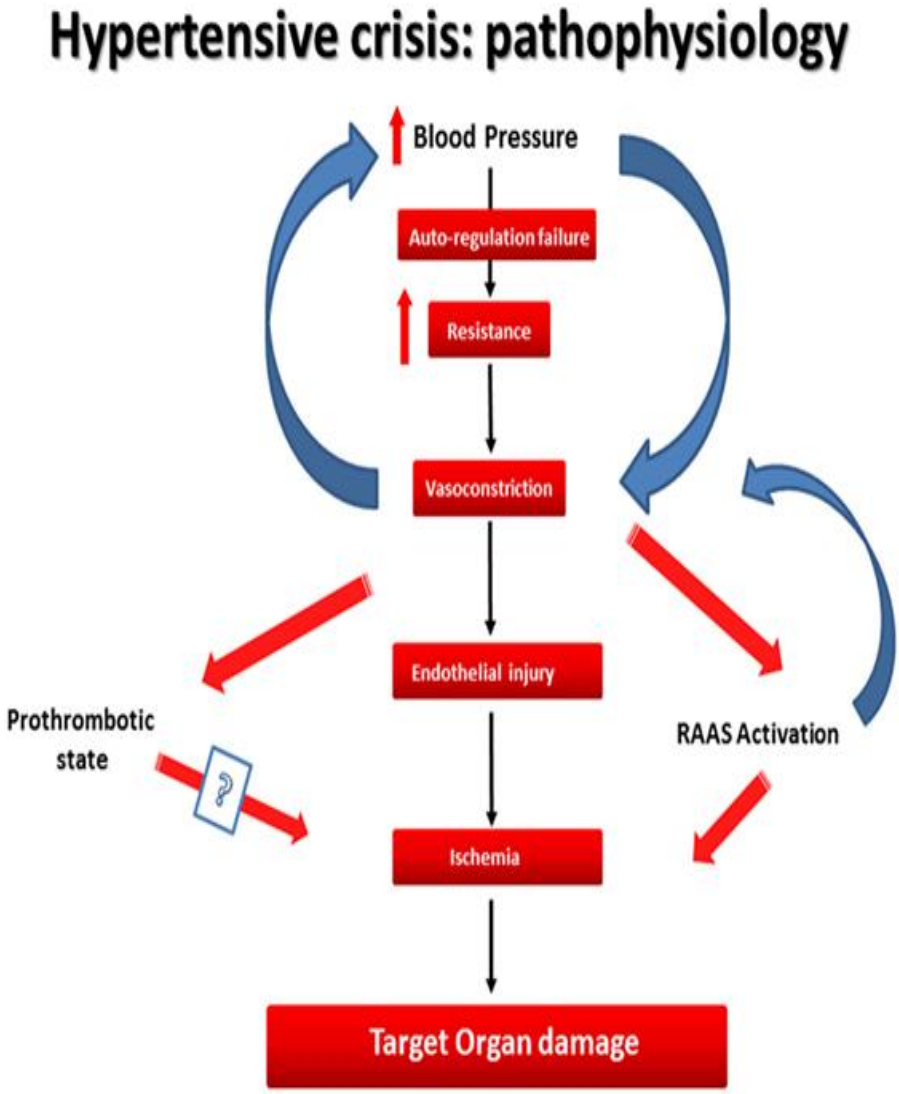

Fig No:01 Pathophysiology of Hypertension

Hypertension (HTN) is a chronic condition characterized by sustained elevation of arterial blood pressure (≥140/90 mmHg). Its development involves multiple interacting mechanisms affecting the heart, blood vessels, kidneys, nervous system, and endocrine system.

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1. Imbalance Between Cardiac Output & Peripheral Vascular Resistance (PVR)
Blood pressure = Cardiac Output (CO) × Peripheral Vascular Resistance (PVR)
Hypertension develops when CO or PVR or both increase
Cardiac Output rises due to ↑ blood volume or ↑ heart rate
PVR increases due to vasoconstriction or reduced elasticity of arteries

2. Sympathetic Nervous System (SNS) Overactivity
SNS hyperactivation causes:
Vasoconstriction → ↑ PVR
↑ Heart rate & contractility → ↑ CO
Increased renin release → activates RAAS system
Reduced baroreceptor sensitivity, so BP remains constantly high
This is commonly seen in:
stress, obesity, sleep apnea, genetic predisposition

3. Renin-Angiotensin-Aldosterone System (RAAS)
Overactivity↑ Renin → ↑ Angiotensin II (strong vasoconstrictor)
Angiotensin II causes: Intense vasoconstriction → ↑ PVR Aldosterone release → Na^+/water retention → ↑ blood volume → ↑ CO Vascular remodeling → long-term hypertension

4. Endothelial Dysfunction
Endothelium loses ability to regulate vessel tone due to ↓ vasodilators and ↑ vasoconstrictors: ↓ Nitric oxide (NO) & prostacyclin↑ Endothelin-1 (potent vasoconstrictor)→ Leads to chronic vasoconstriction & ↑ PVR

5. Sodium & Water Retention (Kidney Dysfunction)
Impaired natriuresis → kidneys retain excess sodium and water↑ Blood volume → ↑ CO Increased intravascular volume also increases vascular stiffness

6. Vascular Remodeling & Increased Arterial Stiffness
Chronic high pressure causes thickening of arterial walls Loss of elasticity → vessels cannot relax properly↑ PVR, especially in elderly and diabetics

7.Genetic & Hormonal Factors
Mutations affecting kidney salt handling Increased adrenal hormones (aldosterone, catecholamines) Insulin resistance → stimulates SNS & RAAS → ↑ PVR.

COMMON BOTONICAL WITH THE STRONGEST EVIDENCE GARLIC

Fig No:02 Diagram of Garlic

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Synonym: Allium sativum, Lasan, Ali Blanc
Biological Source:The bulk of the plant **Allium Sativum**
Family: Alliaceae or Liliaceae
Chemical constituent: allicin (diallyl thiosulfinate)

Garlic, which is used as an antihypertensive drug, is part of the tuber .Garlic is commonly used among hypertensive patients because of its reputed benefit in reducing cardiovascular disease and lowering BP. Other claims for the benefits of garlic have included cancer prevention and anti-inflammation. Studies have suggested a multitude of physiologic effects including inhibition of platelet activity and increased levels of antioxidant enzymes. There are probably several active ingredients in garlic preparations. Not surprisingly, several studies have been done to examine its utility in treating hypertension and hyperlipidemia. In its evidence report, on garlic, the Agency for Health Care Research and Quality reviewed 37 randomized trials and found that garlic preparations did indeed lower total cholesterol by small amounts in the short term but no reduction was observed at 6 months In the treatment of high BP, 27 small randomized placebo controlled trials of short duration were reviewed. Various doses of garlic were used providing about 3 to 6 mg of allicin per day. The majority of these studies found that garlic did not reduce BP compared to placebo, but the studies were small. Interestingly, in one cross-sectional observation study of older patients, garlic intake was found to reduce age-related increases in aortic stiffness.[8] Garlic has been reported to increase the risk of bleeding, probably due to its antiplatelet action, but this is not well studied.[9]

GINGER .

Fig No:03 Diagram of Ginger

Synonym: Zingiberis, Zingibere, Zingiberic rhizome
Biological Source: The Dried Rhizomes of **Zingiber Officinale.**
Family: Zingiberaceae
Chemical constituents: gingerols, Zingerone

Ginger is incredibly versatile and a staple in alternative medicine. People have used it for centuries to improve many aspects of heart health, including circulation, cholesterol levels, and blood pressure. Both human and animal studies have shown that taking ginger reduces blood pressure in several ways. It acts as a natural calcium channel blocker and natural ACE inhibitor. Calcium channel blockers and ACE inhibitors are types of blood pressure medication. A study in more than 4,000people found that those who consumed the most ginger2–4 grams per day had the lowest risk of developing high blood pressure. Ginger is delicious and easy to incorporate into your diet with meals. Alternatively, you can purchase ginger supplements online. These are more concentrated. Ginger appears to lower blood pressure by acting as a natural calcium channel blocker and dilating the blood vessels.

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HIBISCUS

Fig No:04 Diagram of Hibiscus Flower

Synonym: Hibiscus Sabdariffia (Roselle), Hibiscus rosa sinensis (Cinese Hibiscus)
Biological Source: The leaves and flowers of **Hibiscus rosa sinesis linn**
Family: Malvaceae
Chemical constituents: Anthocyanins, particularly
delphinidin-3-sambubioside and cyanidin-3 sambubioside, are generally believed to be the active constituents responsible for the antihypertensive, antioxidant
In folk medicine Hibiscus Sabdariffa Linne HS used for wound dressing, bronchitis, diabetes, cardiac and neurologic diseases, repair of calcified vessel, antispasmodic, hypochlosterolemic antibacterial, antifungal ,anticancer, muscle relaxant effects andrecently as antihypertensive agent.[10] The extract of this plant exerts the antihypertensive activity by at least three major specific mechanisms of action: diuretic ,vasodilator and angiotensin converting enzyme inhibitor (ACE inhibitor) but there are additional mechanisms of action hibiscus exert can reduce high blood pressure on long term use as antioxidant and hypo choletsrolemic which considered as a cardio protective effect. HS act as diuretic by inhibition of sodium (Na+) and water re-absorption it has an advantage over the loop diuretic furosemide that it does not cause over-reactivation of the rennin-angiotensin aldosterone system and maintaining the potassium concentration in the body this was evidenced by the potassium K+ values, corresponding index and the saluretic relationship of Na+ /K+15. ACE inhibitor effect exert by HS due to the blockage of the angiotensin 1 receptor binding to angiotensin II therefore, angiotensin II is not produced and aldosterone is not released from the adrenal gland, which may eventually cause a decrease in the vascular resistance.[11]

CINNAMON

Fig No:05 Digram of Cinnamon

Synonym: Cinnamomum zeylanicum, kalmi, Dalchini, Cortex Cinnamoni
Biological Source: The dried inner bark of the shoots of coppiced trees of
Cinnamomum zeylanicum
Family: Lauraceae

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Chemical Constituents: Cinnamaldehyde, Eugenol, Terpenes

Cinnamon is one of the most important spices used daily by people all over the world. Cinnamon primarily contains vital oils and other derivatives, such as cinnamaldehyde, cinnamic acid, and cinnamate. In addition to being an antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, lipid-lowering, and cardiovascular-disease-lowering compound, cinnamon has also been reported to have activities against neurological disorders, such as Parkinson's and Alzheimer's diseases. A recent study reported the potential effects of two compounds, cinnamic aldehyde and cinnamic acid, isolated from C. cassia against myocardial ischemia,[12] indicating that cinnamon also has the potential to be used to treat cardiovascular diseases.

INDIAN SNAKEROOT

Fig No:06 Diagram of Indian Snakeroot

Synonym: Dhawala vitapa, Chandramara, Sarpasugandha, Sarpagandhakhya

Biological Source: The dried roots of the plant **Rauwolfia Serpentina**

Family: Apocynaceae

Chemical constituents: Reserpine, serpentine, serpentinine, rauwolfinine.

Rauwolfia is cultivated for the medicinal use of its 30 alkaloids (particularly reserpine found in the root), many used in treating hypertension.[13] Besides reserpine, other alkaloids used in hypertension and other cardiac disorders are ajmaline, rescinnamine, serpentinine, sarpagine, deserpidine, and chandrine. Rauwolfia alkaloids work by controlling nerve impulses along certain pathways that affect heart and blood vessels, lowering blood pressure.

Rauwolfia deplete scatecholamines and serotonin from nerves in the central nervous system. In a controlled intervention trial, 389 subjects, ages 21- 55 years, with diastolic blood pressures 90-115 mm Hg were examined for 7-10 years. Subjects were randomly assigned to either a combination of a diuretic and Rauwolfia serpentina, or an identical placebo. Diastolic blood pressure was reduced an average of 10 mm Hg and systolic by 16 mm Hg in the active treatment group, with no change in the placebo group.[14]

The Rauwolfia constituent ajmaline not only lowers blood pressure, but also has a potent antiarrhythmic effect. Studies have shown that ajmaline specifically depresses intraventricular conduction, suggesting this would be particularly effective in the treatment of re-entrant ventricular arrhythmias.[15]

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Ginseng

Fig No:07 Diagram of Ginseng

Synonym: Panax ginseng, Panax pseudoginseng, Panax Schinseng
Biological Source:The dried root and rhizomes of **perennial plant**
Family: Araliaceae
Chemical Constituent: Ginsenosides

Ginseng is marketed either as a single herb compound or in combination with other herbs. The single herb compound is available in tablet as well as in alcoholic extracts (known as tinctures) Experiments in dogs showed that intravenous administration of ginseng extract caused an immediate drop in blood pressure. The effect was long lasting suggesting that it might be facilitated by a Calcium channel blocking like effect and interference with calcium mobilization into vascular smooth muscle cells Rg1, one of the active ingredients in Ginseng can stimulate the production and release of nitric oxide (NO) from endothelial cells.

Another ingredient, Ginsenoside Rb1 lowers blood pressure and acts as a CNS depressant. It also interferes with platelet aggregation and coagulation. Interestingly, Ginseng extracts exhibit a peripheral vasoconstricting effect in low doses and peripheral vasodilatation in high doses. However, in cerebral and coronary vessels it exhibits only a vasodilating effect resulting in improvement in cerebral and coronary blood flow.

Coriander

Fig No:08 Diagram of Coriander

Synonym: Coriandrum sativum (Cilantro or Coriander)
Biological Source: the ripe fruits of **Coriandrum Sativum**
Family: Apiaceae
Chemical Constituents: Volatile oils ,flavonoids

In several countries, coriander (also known as cilantro or dhania) is not only used as a culinary ingredient but also as a traditional medicine for the treatment of cardiovascular and gastrointestinal diseases. Coriander is an excellent remedy to manage high blood pressure. It is packed with heart-friendly fibres. Studies have claimed that constituents from

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coriander interact with calcium ions and the neurotransmitter acetylcholine, which helps relax tension in blood vessel. Additionally, the spice is very effective to modulategut activity, which is very important to manage high blood pressure. Coriander seeds also have a diuretic effect. A diuretic helps increase passing of urine. Through urine you are able to eliminate the excess sodium accumulated in your system

ASHWAGANDHA

Fig No.08 Diagram of Ashwagandha

Synonym: Withania somnifera, Indian ginseng
Biological Source: The Dried root and stem bases of the plant **Withania Somnifera**
Family: Solanaceae
Chemical Constituents: withanolides
Ashwagandha helps reduce hypertension primarily by lowering stress and regulating the sympathetic nervous system. Its active compounds, with anolides, reduce cortisol levels and calm the central nervous system, which decreases heart rate and peripheral vascular resistance. Ashwagandha also improves endothelial function by enhancing nitric oxide production, supports vasodilation, and provides strong antioxidant and anti-inflammatory effects that reduce vascular stiffness. Through these combined actions, Ashwagandha helps in lowering blood pressure, especially in stress-induced or borderline hypertension.

MECHANISM BY WHICH HERBS LOWER BLOOD PRESSURE

1. Vasodilation (Relaxation of Blood Vessels)
Many herbs contain flavonoids, polyphenols, nitrates, and alkaloids that:
Increase nitric oxide (NO) synthesis → smooth muscle relaxation
Block endothelin-1, a potent vasoconstrictor
Inhibit calcium influx into vascular smooth muscle → reduced contraction
Examples: Hibiscus, Garlic, Ginger, Hawthorn, Arjuna.

2. ACE Inhibition (Renin–Angiotensin System Modulation)
Certain phytochemicals inhibit Angiotensin-Converting Enzyme (ACE) → decreased angiotensin-II formation → vasodilation and reduced aldosterone levels.
Examples: Garlic (allicin), Hibiscus (protocatechuic acid), Lavender, Celery seed.

3. Diuretic Effect
Some herbs increase urine output, reducing plasma volume and cardiac preload, resulting in lower blood pressure.
Examples: Punarnava, Dandelion, Hibiscus, Celery seed.

4. Calcium Channel Blocking Activity
Calcium channel blockers reduce calcium entry into muscles → vasodilation and lower BP.
Some herbs mimic this mechanism naturally.
Examples: Ginger (gingerol, shogaol), Hibiscus, Crataegus (Hawthorn).

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5. Antioxidant Activity

Oxidative stress stiffens blood vessels and reduces nitric oxide availability. Antioxidant-rich herbs:
Protect endothelial cells
Improve NO bioavailability, Reduce vascular inflammation
Examples: Green tea, Hibiscus, Garlic, Turmeric

6. Sympatholytic Effects

Some herbs reduce sympathetic nervous system activity (stress-induced rise in BP).
Examples: Ashwagandha, Brahmi, Jatamansi.

7. Anti-inflammatory Action

Chronic vascular inflammation contributes to hypertension. Anti-inflammatory phytochemicals improve endothelial function and reduce vascular resistance.
Examples: Turmeric (curcumin), Ginger, Garlic.

COMPARATIVE DISCUSSION

HERBAL MEDICINE VS SYNTHETIC ANTIHYPERTENSIVE DRUG

A. Safety Profile

Herbal Medicine

Generally considered safer with fewer side effects.
Mild actions → less risk of sudden BP drop.
Usually well-tolerated during long-term use.
Fewer reports of renal dysfunction, electrolyte imbalance, or severe hypotension.
Side effects are mild (GI upset, allergic reactions).
Possible herb–drug interactions (e.g., garlic with anticoagulants).

Synthetic Antihypertensive Drugs

Stronger pharmacological effects → more rapid BP control.
Higher risk of adverse effects:
ACE inhibitors → dry cough, hyperkalemia
CCBs → pedal edema, headache
Diuretics → electrolyte imbalance
Beta blockers → fatigue, bradycardia
Require monitoring of ECG, renal function, and electrolytes.
Contraindications exist in pregnancy, asthma, renal disease, etc.

B. Advantages

Herbal Medicine

Natural and holistic approach.
Acts via multiple mechanisms: antioxidant, anti-inflammatory, ACE inhibition, diuretic effects.
Beneficial for mild to moderate hypertension.
Improves overall cardiovascular health (stress reduction, lipid lowering).
Cheaper and more accessible in many regions.
Fewer long-term adverse effects.

Synthetic Antihypertensive Drugs

Precise, predictable, and strong pharmacological action.
Essential for moderate to severe hypertension.

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Well-defined mechanisms and dosages.
Rapid symptomatic relief.
Supported by extensive clinical trial data.
Life-saving in hypertensive emergencies.

C. Limitations

Herbal Medicine

Slower onset of action.
Effectiveness varies with dose, preparation, and plant quality.
Lack of standardization in many products.
Limited large-scale clinical trials.
Possible contamination or adulteration in commercial herbal products.
Cannot replace synthetic drugs in severe hypertension.

Synthetic Drugs

More side effects and long-term toxicities.
Potential for dependence (beta-blockers).
Drug interactions sometimes significant.
Expensive (for some classes).

D. Standardization Issues in Herbal Medicine

Standardization is a major challenge in herbal therapy.
Key Problems:

1. Variability in Active Compounds

Depends on:
Soil, climate, and season
Extraction methods
Part of plant used

2. Lack of Dose Consistency

Herbal formulations often lack fixed concentrations of active molecules (e.g., withanolides in Ashwagandha).

3. Quality Control Issues

Adulteration
Heavy metal contamination
Pesticides or microbial contamination

4. Incomplete Clinical Evidence

Not enough large-scale randomized controlled trials.
5. Regulatory Challenges
Many herbal products are categorized as supplements, not medicines → quality varies

6. Stability Issues

Shelf life and storage conditions affect potency.

FUTURE PROSPECTS

NEED FOR CLINICAL TRIALS
STANDARDIZATION OF DOSES
POTENSIAL FOR NEW PHYTOMEDICINES

The future of herbal antihypertensive medicine is highly promising as many medicinal plants show significant blood pressure–lowering effects through mechanisms such as ACE inhibition, calcium-channel blocking, diuretic action, and

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antioxidant activity. However, advancement requires well-designed clinical trials to confirm safety, efficacy, long-term effects, and herb–drug interactions. There is also an urgent need for standardization of herbal formulations, including consistent extraction methods, identification of active phytochemicals, fixed therapeutic doses, and quality control to ensure purity and potency. [20] With advances in phytochemistry and biotechnology, there is great potential for discovering new phytomedicines, isolating bioactive compounds, and developing plant-based antihypertensive drugs that are safer, more affordable, and effective for mild to moderate hypertension. Thus, combining traditional knowledge with modern research can lead to novel, evidence-based herbal antihypertensive therapies.[21]

II. CONCLUSION

Herbal medicines play a valuable supportive role in the management of hypertension due to their multi-targeted actions such as ACE inhibition, vasodilation, antioxidant activity, diuretic effects, and reduction of stress and inflammation. Many medicinal plants like garlic, hibiscus, ginger, and ashwagandha show significant antihypertensive potential with fewer side effects compared to synthetic drugs. However, while these herbs are promising, their clinical use is limited by variability in quality, lack of standardization, and insufficient large-scale clinical trials. Therefore, herbal medicines are best used as complementary therapies, especially in mild to moderate hypertension, whereas synthetic antihypertensive drugs remain essential for severe or uncontrolled cases. Continued research, proper standardization, and evidence-based validation can further enhance the therapeutic potential of herbal antihypertensive agents.

Herbal medicines have long been used worldwide to treat hypertension. In recent decades randomized trials, systematic reviews and mechanistic studies have investigated a number of botanicals showing modest but clinically meaningful reductions in blood pressure for some agents and plausible mechanisms (vasodilation, antioxidant effects, RAAS/ACE modulation, diuresis). Evidence quality is heterogeneous, safety and herb–drug interactions are important concerns, and larger, standardized trials with well-characterized preparations are needed before many herbal products can be recommended as routine antihypertensive therapy. Key clinical and mechanistic findings are summarized below.

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