

Polyherbal Approaches in the Management of Hypertension: A Review on Synergistic Effects of Medicinal Plants.

ABSTRACT:

Hypertension is a significant health issue worldwide and a primary risk factor for cardiovascular conditions like stroke, heart attack, and heart failure. Despite the availability of various synthetic antihypertensive drugs, their long-term use is often associated with adverse effects and poor patient compliance. This has led to growing interest in herbal and polyherbal therapies as safer and more effective alternatives. Polyherbal formulations, comprising multiple medicinal plants, can improve therapeutic effects through synergistic interactions. This review examines the antihypertensive properties of medicinal plants such as *Terminalia arjuna*, *Tribulus terrestris*, *Allium sativum*, and *Moringa oleifera*. These plants contain bioactive phytochemicals such as flavonoids, saponins, tannins, alkaloids, and organosulfur compounds that help lower blood pressure through mechanisms including vasodilation, antioxidant effects, diuretic activity, and inhibition of the renin-angiotensin-aldosterone system. The concept of synergism in polyherbal formulations enables a multi-target approach, improving efficacy while reducing toxicity. Although promising, polyherbal formulations still face challenges, including a lack of standardization and limited clinical evidence. Further research and clinical validation are essential to establish polyherbal formulations as effective therapeutic options for hypertension management.

Keywords

Hypertension, polyherbal formulation, medicinal plants, synergistic effect, antihypertensive activity, phytochemicals

1. INTRODUCTION

Hypertension is a long-term heart and blood vessel condition marked by consistently high blood pressure, and it ranks among the major causes of illness and death worldwide. It is a major risk factor for serious health complications such as stroke, myocardial infarction, heart failure, and renal dysfunction. According to the World Health Organization, hypertension affects about 1.28 billion adults worldwide, many of whom go undiagnosed or untreated, particularly in low- and middle-income countries [1].

The pathogenesis of hypertension is complex and involves multiple physiological mechanisms, including overactivation of the renin-angiotensin-aldosterone system (RAAS), increased sympathetic nervous system activity, endothelial dysfunction, and oxidative stress [2,3]. These factors increase peripheral vascular resistance, promote vascular remodeling, and reduce vasodilation, resulting in sustained high blood pressure.

Widely used to treat hypertension, conventional antihypertensive medications include angiotensin-converting enzyme (ACE) inhibitors, beta-blockers, calcium channel blockers, and diuretics [3].

39 Although these medications are effective in controlling blood pressure, their long-term use is often
40 associated with adverse effects such as dizziness, fatigue, electrolyte imbalance, and reduced patient
41 compliance. Additionally, monotherapy may not be sufficient for effective management due to the
42 multifactorial nature of the disease[4].

43 Recently, interest in herbal medicine as an alternative or complementary method for managing
44 hypertension has increased. Medicinal plants contain bioactive compounds such as flavonoids,
45 alkaloids, tannins, and saponins. These substances can help lower blood pressure through
46 vasodilation, diuretic effects, antioxidant properties, and RAAS system inhibition [5,6]. Much
47 research has been dedicated to plants like *Terminalia arjuna*, *Tribulus terrestris*, *Allium sativum*, and
48 *Moringa oleifera* for their heart-protective and antihypertensive qualities [6-9].

49 The concept of polyherbal, which involves the use of multiple medicinal plants in combination, is a
50 fundamental principle of traditional systems of medicine such as Ayurveda. Polyherbal formulations
51 are believed to produce synergistic effects, where the combined action of different plant constituents
52 enhances therapeutic efficacy while minimizing toxicity [10]. This approach is particularly
53 beneficial in the management of complex diseases like hypertension, where multiple pathways are
54 involved.

55 Therefore, the present review aims to explore the role of polyherbal formulations in the
56 management of hypertension, with a focus on the synergistic effects, mechanisms of action, and
57 therapeutic potential of selected medicinal plants.

58

59 2. PATHOPHYSIOLOGY OF HYPERTENSION

60 Hypertension is a complex and multifactorial disorder involving the interaction of genetic,
61 environmental, and physiological factors that regulate blood pressure. The development and
62 progression of hypertension are primarily associated with disturbances in vascular function,
63 neurohormonal systems, and renal regulation [11].

64 One of the most important mechanisms involved in hypertension is the overactivation of the renin-
65 angiotensin-aldosterone system (RAAS). Renin, released from the kidneys, converts
66 angiotensinogen into angiotensin I, which is further converted into angiotensin II by angiotensin-
67 converting enzyme (ACE). Angiotensin II is a potent vasoconstrictor that increases peripheral
68 resistance and stimulates aldosterone secretion, leading to sodium and water retention, thereby
69 elevating blood pressure [12].

70 Endothelial dysfunction also plays a critical role in the pathogenesis of hypertension. The
71 endothelium regulates vascular tone by releasing vasodilators such as nitric oxide. Hypertension
72 leads to a decrease in nitric oxide availability and a rise in vasoconstrictors like endothelin, which
73 together cause reduced vasodilation and greater vascular resistance [13].

74 Another important cause of hypertension is oxidative stress. This condition occurs when there is an
75 unequal balance between reactive oxygen species and the body's antioxidant defences. Excess
76 reactive oxygen species leads to vascular damage, inflammation, and further reduction in nitric
77 oxide availability, thereby promoting vasoconstriction and hypertension [14].

78 Additionally, the sympathetic nervous system plays a major role in the development of
79 hypertension. Elevated sympathetic activity raises cardiac output, heart rate, and vasoconstriction,
80 all of which raise blood pressure [15].

81 Renal mechanisms are equally important in blood pressure regulation. The kidneys control fluid
82 balance and sodium excretion. Impaired renal function can lead to sodium retention and increased
83 blood volume, which in turn raises blood pressure. Additionally, abnormalities in pressure
84 natriuresis further contribute to sustained hypertension [16].

85 Furthermore, vascular remodeling, characterized by structural changes in blood vessel walls such as
86 thickening and reduced elasticity, contributes to enhanced peripheral resistance and maintenance of
87 high blood pressure [17].

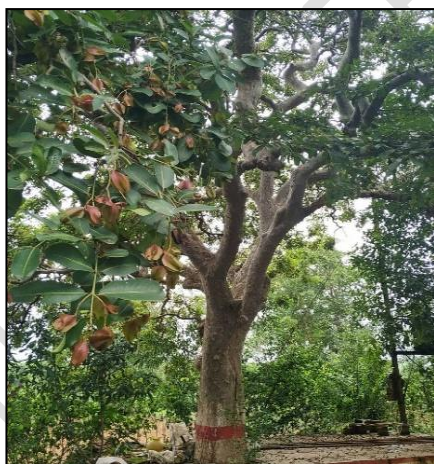
88 Thus, hypertension results from the combined effects of neurohormonal activation, endothelial
89 dysfunction, oxidative stress, and renal impairment, making it a complex condition that requires
90 multi-targeted therapeutic approaches.

91

92 3. MEDICINAL PLANTS WITH ANTIHYPERTENSIVE ACTIVITY

93 Traditional medicine has relied on medicinal plants to help prevent and manage high blood
94 pressure. These plants contain flavonoids, alkaloids, tannins, and saponins that reduce blood
95 pressure. Their actions include widening blood vessels, increasing urine production, acting as
96 antioxidants, and affecting the renin-angiotensin-aldosterone system (RAAS). Many people
97 consider medicinal plants to be a safer, cost-effective, and more suitable option for prolonged
98 treatment compared to synthetic medications [18,19].

99 3.1 *Terminalia arjuna* (Common Names: Arjuna, Arjun tree, Kahu)



100
101 **Fig. 3.1: Arjuna Tree and Bark**

102 *Terminalia arjuna*, commonly known as **Arjuna**, is a well-known medicinal plant widely used in
103 Ayurveda for the treatment of cardiovascular disorders. This plant is part of the **Combretaceae**
104 family and grows in India as well as various regions of Southeast Asia. The plant's bark, which is
105 rich in bioactive substances such as flavonoids, tannins, triterpenoids, glycosides, saponins, and

106 minerals, is its most useful component for medicinal purposes. These phytoconstituents have
107 antihypertensive, antioxidant, and cardioprotective properties [20].

108 **Table 1: Taxonomical Classification of *Terminalia arjuna***

Kingdom	Plantae
Family	Combretaceae
Genus	<i>Terminalia</i>
Species	<i>Terminalia arjuna</i>
Class	Magnoliopsida
Order	Myrtales

109

110 **Table 2: Phytochemical Constituents of *Terminalia arjuna***

Phytochemical Class	Constituents
Flavonoids	Arjunone, Arjunolone, Luteolin
Tannins	Ellagic acid, Gallic acid
Triterpenoids	Arjunic acid, Arjunolic acid, Arjunetin
Glycosides	Ellagic acid, Gallic acid
Saponins	Ellagic acid, Gallic acid
Minerals	Calcium, Magnesium, Zinc, Copper

111

112 These constituents contribute to its antioxidant, cardioprotective, and antihypertensive properties
113 [20,21].

114

115

116 3.1.1 Pharmacological Actions of *Terminalia arjuna*

117 Cardioprotective Activity

118 *Terminalia arjuna* is widely known for its strong cardioprotective effect, helping to improve
119 myocardial function, strengthen heart muscles, and protect against ischemic damage due to the
120 presence of triterpenoids like arjunolic acid.

121 Antihypertensive Activity

122 It helps lower blood pressure by inducing vasodilation and improving endothelial function;
123 flavonoids and tannins play a significant role in relaxing blood vessels.

125 Antioxidant Activity

126 Rich in polyphenols and flavonoids, it serves as a potent antioxidant, scavenging free radicals and
127 lowering oxidative stress, which is a key cause of cardiovascular illnesses.

129 Hypolipidemic Effect

130 Arjuna helps in lowering cholesterol and triglyceride levels, thus preventing atherosclerosis and
131 improving lipid profile.

132 Anti-inflammatory Activity

133 It exhibits anti-inflammatory effects by inhibiting inflammatory mediators, thereby reducing
134 inflammation in cardiovascular and other tissues.

136 3.1.2 Mechanism of Action

137 The antihypertensive activity of *Terminalia arjuna* is mediated through multiple mechanisms:

- 138 • Enhancement of nitric oxide (NO) release → vasodilation
- 139 • Inhibition of lipid peroxidation → protects blood vessels.
- 140 • Calcium channel blocking activity → reduces vascular contraction.
- 141 • Antioxidant action → improves endothelial function.

142 These combined effects help in reducing blood pressure and improving cardiovascular health
143 [21,22].

145 3.1.3 Pharmacological Studies

146 Several experimental and clinical studies have demonstrated the effectiveness of *Terminalia arjuna*:

- 147 • Reduction in systolic and diastolic blood pressure
- 148 • Improvement in cardiac output
- 149 • Reduction in oxidative stress markers

150 Clinical studies have shown significant improvement in patients with hypertension and ischemic
151 heart disease after administration of Arjuna bark extract [20,22].

152 **3.2 Tribulus terrestris**(Common Names: Gokhru, Gokshura, Puncture Vine)



153
154 **Fig.3.2: Gokhru Plant and Fruits**

155 Tribulus terrestris, commonly known as **Gokhru**, is a significant medicinal plant used in ancient
156 medical systems like Ayurveda to treat cardiovascular, reproductive, and urinary diseases. It is
157 extensively distributed in tropical and subtropical regions and is a member of the **Zygophyllaceae**
158 family. The plant's fruits and aerial parts are used medicinally, particularly for their diuretic and
159 antihypertensive properties[23].

160
161 **Table 3: Taxonomical Classification of Tribulus terrestris**

Kingdom	Plantae
Family	Zygophyllaceae
Genus	<i>Tribulus</i>
Species	<i>Tribulus terrestris</i>
Class	Magnoliopsida
Order	Zygophyllales

162
163 **Table 4: Phytochemical Constituents of Tribulus terrestris**

Phytochemical Class	Constituents
Alkaloids	Harmene, Harmine, Norharmene
Flavonoids	Kaempferol, Quercetin, Rutin

Tannins	Hydrolysable tannins
Triterpenoids	Triterpenes
Glycosides	Steroidal glycosides, Furostanol glycosides
Saponins	Protodioscin, Prototribestin, Dioscin, Tribulosin
Phenolic compounds	Caffeic acid, Ferulic acid

These phytoconstituents contribute to its diuretic, antihypertensive, and antioxidant activities [23,24].

3.2.1 Pharmacological Actions of *Tribulus terrestris*

Antihypertensive Activity

Tribulus terrestris exhibits significant antihypertensive effects primarily due to its rich content of steroidal saponins such as protodioscin, which promote vasodilation by enhancing nitric oxide release from endothelial cells, thereby reducing peripheral vascular resistance and lowering blood pressure.

Diuretic Activity

The plant acts as a natural diuretic by increasing urine output, facilitating the excretion of excess sodium and water, which contributes to blood pressure reduction and supports kidney function.

Cardioprotective Activity

It protects cardiac tissues by reducing oxidative stress, improving coronary circulation, and stabilizing heart muscle function, thereby helping in the prevention of ischemic heart conditions.

Antioxidant Activity

The presence of flavonoids and phenolic compounds such as quercetin and rutin helps in scavenging free radicals, reducing oxidative damage, and preventing cellular injury.

Hypolipidemic Activity

Tribulus terrestris helps in lowering serum cholesterol, triglycerides, and LDL levels while increasing HDL levels, thus reducing the risk of atherosclerosis.

3.2.2 Mechanism of Action

Tribulus terrestris has an antihypertensive impact that is mediated by several mechanisms:

- Diuretic action: lowers cardiac output and plasma volume.

- Vascular resistance is reduced by smooth muscle relaxation.
- Vasodilation is improved by nitric oxide modulation.
- Endothelial function is protected by the antioxidant action.

Together, these systems help in the efficient control of blood pressure[24,25].

3.2.3 Pharmacological Studies

Experimental and clinical research have indicated

- Both the systolic and diastolic blood pressure significantly decrease
- Better electrolyte balance and renal function
- A decrease in indicators of oxidative stress

Animal studies have demonstrated that *Tribulus terrestris* extract produces a notable hypotensive effect, supporting its traditional use [23,25].

3.3 *Allium sativum*(Common Names:Garlic, Lahsun, Poondu)



Fig. 3.3: Garlic Plant and Bulb

Allium sativum, commonly known as **garlic**, is one of the most extensively studied medicinal plants with significant therapeutic potential in cardiovascular diseases, including hypertension. It belongs to the family **Amaryllidaceae** and has been used for centuries in traditional medicine systems worldwide. Garlic is well known for its antihypertensive, hypolipidemic, antioxidant, and cardioprotective properties. The therapeutic effects of garlic are attributed to sulfur-containing compounds such as allicin [26].

Tablet 5: Taxonomical Classification of *Allium sativum*

Kingdom	Plantae
Family	Amaryllidaceae

Genus	<i>Allium</i>
Species	<i>Allium sativum</i>
Class	Liliopsida
Order	Asparagales

Table 6: Phytochemical Constituents of *Allium sativum*

Phytochemical Class	Constituents
Flavonoids	Quercetin, Kaempferol
Vitamins	Vitamin C, Vitamin B6
Amino acids	Cysteine, Methionine
Saponins	Diosgenin, Gitogenin
Minerals	Selenium, Calcium, Phosphorus, Potassium
Organosulfur compounds	Allicin, Alliin, Ajoene, Diallyl sulfide, Diallyl disulfide,

Among these, **allicin** is the most active compound responsible for antihypertensive effects [26,27].

3.3.1 Pharmacological Actions of *Allium sativum*

Antihypertensive Activity

Garlic lowers blood pressure through vasodilation by increasing the synthesis of nitric oxide (NO) and inhibiting the angiotensin-converting enzyme (ACE). It helps manage hypertension because it relaxes vascular smooth muscles and lowers peripheral resistance.

Antihyperlipidemic Activity

It lowers total cholesterol, LDL, and triglycerides while increasing HDL levels. Garlic inhibits hepatic cholesterol synthesis and enhances lipid metabolism, thus preventing atherosclerosis.

Cardioprotective Activity

227 Garlic protects the heart by improving lipid profile, reducing blood pressure, preventing plaque
228 formation, and enhancing endothelial function.

229 **Antioxidant Activity**

230 Rich in sulfur compounds and flavonoids, garlic scavenges free radicals, reduces oxidative stress,
231 and protects cells from damage. This contributes to cardiovascular protection and anti-aging effects.

232 **Antiplatelet and Antithrombotic Activity**

233 Garlic inhibits platelet aggregation by suppressing thromboxane formation and enhancing
234 fibrinolytic activity, thereby reducing the risk of thrombosis and cardiovascular diseases.

235 **3.3.2 Mechanism of Action**

236 The antihypertensive effect of *Allium sativum* is mediated through multiple mechanisms:

- 237 • Vasodilation by the release of nitric oxide (NO)
- 238 • Angiotensin-converting enzyme (ACE) inhibition
- 239 • The synthesis of hydrogen sulphide (H₂S) relaxes vascular smooth muscles.
- 240 • A decrease in oxidative stress

241 These mechanisms collectively contribute to lowering blood pressure and improving cardiovascular
242 health [27,28].

243

244 **3.3.3 Pharmacological Studies**

245 Numerous clinical and experimental studies have demonstrated the antihypertensive efficacy of
246 garlic:

- 247 • Significant reduction in systolic and diastolic blood pressure
- 248 • Improvement in lipid profile
- 249 • Reduction in cardiovascular risk factors

250 Clinical studies have demonstrated that taking garlic supplements can lower blood pressure in some
251 patients to a degree like standard antihypertensive medications [28].



252 3.4 *Moringa oleifera* (Common Names: Drumstick tree, Sahjan, Miracle)

253 **Fig.3.4: Moringa Tree and Leaves**

254 *Moringa oleifera*, also referred to as **drumstick tree** or “**Miracle Tree**,” is a highly valued
 255 medicinal plant widely used in traditional medicine for the treatment of various diseases, including
 256 hypertension. It belongs to the family **Moringaceae** and is native to India. Although the plant's
 257 leaves are particularly valued for their therapeutic properties, all sections of the plant have
 258 therapeutic effects. The antihypertensive, antioxidant, and anti-inflammatory properties of moringa
 259 are attributed to its abundance of vital minerals and bioactive substances[29].

260

261 **Table 7: Taxonomical Classification of *Moringa oleifera***

Kingdom	Plantae
Family	Moringaceae
Genus	<i>Moringa</i>
Species	<i>Moringa oleifera</i>
Class	Magnoliopsida
Order	Brassicales

262

263 **Table 8: Phytochemical Constituents of *Moringa oleifera***

Phytochemical Class	Constituents
Alkaloids	Moringine, Moringinine

Flavonoids	Quercetin, Kaempferol, Rutin
Tannins	Condensed tannins
Phenolic Compound	Chlorogenic acid, Caffeic acid, Gallic acid
Glycosides	Cardiac glycosides, Thiocarbamate glycosides
Vitamins	Vitamin A, Vitamin C, Vitamin E
Minerals	Calcium, Potassium, Iron, Magnesium

Among these, **quercetin** plays a significant role in blood pressure reduction due to its vasodilatory properties [29,30].

3.4.1 Pharmacological Actions of *Moringa oleifera*

Antihypertensive Activity

Moringa helps reduce blood pressure due to the presence of bioactive compounds like nitrile, thiocarbamate, and isothiocyanate glycosides, which function as vasodilators and improve blood circulation.

Antioxidant Activity

It is rich in antioxidants such as quercetin, chlorogenic acid, and vitamin C, which neutralise free radicals and protect cells from oxidative stress.

Cardioprotective Activity

Moringa protects the heart by reducing lipid levels, preventing plaque formation, and improving overall cardiovascular function.

Diuretic Activity

It increases urine output, helping in the elimination of excess salts and fluids, which is beneficial in hypertension.

Antimicrobial Activity

It shows activity against bacteria, fungi, and some viruses due to the presence of compounds like pterygospermin and benzyl isothiocyanate.

3.4.2 Mechanism of Action

Moringa oleifera lowers blood pressure through the following mechanisms:

- 288 • Vasodilation via nitric oxide (NO) pathway
- 289 • Calcium channel blocking activity
- 290 • Reduction of oxidative stress
- 291 • Diuretic effect (mild)

292 These mechanisms help in reducing peripheral resistance and improving blood flow, thereby
293 lowering blood pressure [30,31].

294

295 3.4.3 Pharmacological Studies

296 Various experimental and clinical studies have reported:

- 297 • Significant decreases in both the diastolic and systolic blood pressure
- 298 • An increase in the amounts of antioxidant enzymes
- 299 • Protection against cardiovascular disorders

300 Animal studies and preliminary human studies support the antihypertensive potential of *Moringa*
301 *oleifera* [29,31].

302

303 4. SYNERGISTIC MECHANISMS OF POLYHERBAL FORMULATIONS

304 Polyherbal formulations are based on the principle that the combination of multiple medicinal
305 plants can produce enhanced therapeutic effects compared to single-drug therapy. This phenomenon
306 is known as **synergism**, where the combined action of different phytoconstituents results in
307 improved efficacy and reduced toxicity [32].

308 In the management of hypertension, polyherbal formulations are particularly helpful because the
309 disease involves multiple pathophysiological pathways such as oxidative stress, endothelial
310 dysfunction, overactivation of the renin–angiotensin–aldosterone system (RAAS), and increased
311 sympathetic activity. A single drug may not effectively target all these mechanisms, while a
312 combination of herbal agents can act on multiple targets simultaneously [33].

313

314 4.1 Mechanisms of Synergistic Action

315 Polyherbal formulations show synergistic effects through various mechanisms:

316 Multi-target Action

317 Different plant constituents influence various physiological pathways, including vasodilation,
318 increased urine production (diuresis), antioxidant activity, and inhibition of angiotensin-converting
319 enzyme (ACE). These combined mechanisms may contribute to better blood pressure
320 regulation[34].

321 Pharmacodynamic Synergism

322 Pharmacodynamic synergism occurs when two or more herbs produce similar therapeutic effects,
323 resulting in an enhanced overall response. Garlic helps promote vasodilation, while *Moringa*

324 provides antioxidant effects and also supports vasodilation. Together, these actions may improve
325 their overall effectiveness in reducing blood pressure.

326 **Pharmacokinetic Synergism**

327 One plant may enhance the absorption, distribution, or bioavailability of another, improving overall
328 effectiveness [35].

329 **Reduction of Toxicity**

330 Certain herbs reduce the side effects of others, improving safety and tolerability in long-term use
331 [32].

332

333 **4.2 Synergistic Effects of Selected Medicinal Plants**

334 The combination of Terminalia arjuna, Tribulus terrestris, Allium sativum, and Moringa oleifera
335 provides a comprehensive antihypertensive effect:

336 **Table 9: Synergistic Effects of Selected Medicinal Plants**

Plant	Action
Terminalia arjuna	Cardioprotective
Tribulus terrestris	Diuretic action
Allium sativum	ACE inhibition & vasodilation
Moringa oleifera	Antioxidant & vascular protection

337

338 Together, these medicinal plants may provide several beneficial effects, including reducing vascular
339 resistance, improving cardiac function, maintaining fluid balance, and decreasing oxidative stress.
340 This combined approach may offer better therapeutic outcomes than the use of a single treatment
341 alone[33,34].

342

343 **4.3 Advantages of Polyherbal Synergism**

- 344
- 345 • Enhanced therapeutic effectiveness
 - 346 • Reduced dosage requirements for individual medications
 - 347 • Diminished incidence of adverse effects
 - 348 • Increased patient adherence to treatment
 - 349 • Improved management of chronic conditions such as hypertension [32,35]

349 **4.4 Challenges in Polyherbal Formulations**

350 Although there are notable benefits, certain limitations remain:

- 351
- 352 • Lack of standardization
 - Variability in phytochemical composition

- Difficulty in identifying active components
- Limited clinical validation [33]

5. PHYTOCHEMICAL BASIS OF ANTIHYPERTENSIVE ACTIVITY

Medicinal plants help in lowering blood pressure due to a variety of bioactive phytochemicals. These compounds influence neurohormonal pathways that are crucial for blood pressure regulation, enlarge blood vessels, function as antioxidants, and encourage diuresis[36].

Table 10: Phytochemical Basis of Antihypertensive Activity

S. No.	Phytochemical Class	Examples	Mechanism of Action	Antihypertensive Effect	References
1	Flavonoids	Quercetin, Kaempferol	Increase Nitric oxide (NO) production, antioxidant activity	Vasodilation, Lower vascular resistance	[36,37]
2	Alkaloids	Reserpine (plant alkaloid)	Acts on the CNS and reduces sympathetic activity	Lowers heart rate and Blood Pressure	[36]
3	Saponins	Protodioscin	Diuretic action, increases sodium excretion	Lower blood volume and blood pressure	[38]
4	Tannins	Ellagic acid	Antioxidant, vascular protection	Improves endothelial function	[37]
5	Phenolic compounds	Chlorogenic acid	Reduces oxidative stress	Improves vascular elasticity	[36]
6	Organosulfur compounds	Allicin (Garlic)	ACE inhibition, NO release	Vasodilation, lower Blood Pressure	[26,27]
7	Terpenoids	Arjunolic acid	Cardioprotective, antioxidant	Improves cardiac function	[20,21]
8	Glycosides	Cardiac glycosides	Improves myocardial contractility	Supports heart function	[20]

363 6. ADVANTAGES OF POLYHERBAL THERAPY

- 364 • Polyherbal therapy provides a multi-target approach, acting on different physiological
- 365 pathways involved in hypertension.
- 366 • It shows enhanced therapeutic efficacy due to the synergistic interaction of multiple plant
- 367 constituents.
- 368 • It requires lower doses of individual herbs, which helps in minimizing toxicity.
- 369 • It has reduced side effects compared to synthetic antihypertensive drugs.
- 370 • It is safe for long-term use in chronic conditions like hypertension.
- 371 • It is cost-effective and affordable for a large population.
- 372 • It improves patient compliance due to fewer adverse effects and natural origin.
- 373 • It provides antioxidant, anti-inflammatory, and cardioprotective effects simultaneously.
- 374 • It helps in better management of comorbid conditions such as hyperlipidemia and
- 375 cardiovascular disorders.
- 376 • It uses natural and easily available resources, especially in traditional medicine systems.
- 377 • It can enhance the bioavailability of active constituents through synergistic interactions.
- 378 [39].

379

380 7. LIMITATIONS OF POLYHERBAL FORMULATIONS

- 381 • Polyherbal formulations lack standardized composition and dosage.
- 382 • Phytochemical content varies by plant source, season, and processing.
- 383 • Quality control challenges hinder batch consistency.
- 384 • Clinical evidence is insufficient; few large-scale trials exist.
- 385 • Herb-drug interactions are possible.
- 386 • Identifying active constituents is complex due to multiple ingredients.
- 387 • Dose optimization is difficult for multi-herb blends.
- 388 • Risks include adulteration and contamination (heavy metals, pesticides, microbes).
- 389 • Stability and shelf-life concerns may reduce efficacy.
- 390 • Limited scientific evidence supports their mechanisms [40].

391

392 8. FEW RESEARCH WORKS

393

394 **Chowdhury S et al. (2025).** The review highlights that *Allium sativum* (garlic) is an effective herbal
395 agent in the management of hypertension, showing significant reductions in both systolic and
396 diastolic blood pressure comparable to standard antihypertensive drugs. Garlic, particularly in the
397 form of aged garlic extract, demonstrates consistent BP-lowering effects over prolonged use. Its
398 therapeutic action is assigned to multiple mechanisms, including enhancement of nitric oxide
399 production, inhibition of angiotensin-converting enzyme (ACE), reduction of angiotensin II levels,
400 and suppression of inflammatory pathways. Additionally, garlic exhibits antioxidant, anti-
401 inflammatory, and hypocholesterolemic properties, making it a promising adjunct therapy for
402 improving cardiovascular health in hypertensive patients.

403

404 **Komal C et al. (2025).** The study on polyherbal antihypertensive tablets concludes that formulations
405 containing herbs such as *Allium sativum*, *Ocimum sanctum*, and *Coleus forskohlii* demonstrate

406 promising effectiveness in managing hypertension. The prepared tablets showed acceptable
407 physicochemical properties, including proper hardness, low friability, and suitable disintegration
408 time, indicating good formulation quality. The antihypertensive activity is attributed to active
409 constituents like allicin, flavonoids, and diterpenoids, which promote vasodilation and antioxidant
410 effects. Overall, the study suggests that polyherbal formulations provide a synergistic, safe, and
411 effective alternative to conventional therapy, though further clinical studies are needed for
412 validation.

413

414 **Umarkar et al. (2025).**In this study, a polyherbal antihypertensive formulation indicates that
415 combining multiple medicinal plants, such as *Allium sativum*, *Rauwolfia serpentina*, *Hibiscus*
416 *sabdariffa*, *Terminalia arjuna*, and *Moringa oleifera*, provides a synergistic approach for managing
417 hypertension. These herbs act through multiple mechanisms, including ACE inhibition,
418 vasodilation, antioxidant activity, and diuresis, leading to effective blood pressure reduction. Studies
419 suggest that polyherbal formulations offer better therapeutic efficacy with reduced side effects
420 compared to single-drug therapy. The integration of traditional herbal knowledge with modern
421 pharmaceutical techniques enhances safety, stability, and clinical effectiveness.

422

423 **Kunal S et al. (2024).**In this study, the authors describe *Terminalia arjuna* as an important
424 cardioprotective medicinal plant with significant antihypertensive potential. They report that the
425 stem bark of Arjuna is primarily used and exhibits hypotensive activity by promoting vasodilation
426 and reducing heart rate, thereby helping in the management of high blood pressure. The plant is also
427 highlighted for its common use as a cardiotonic, supporting overall heart function as well as
428 improving cardiovascular health. The authors further note its morphological characteristics and
429 extraction methods, emphasizing its inclusion as a key active ingredient in the formulated herbal
430 tablet. Overall, Arjuna is presented as a vital component in polyherbal therapy for hypertension due
431 to its combined effects on vascular relaxation and cardiac function.

432

433 **Ashraf R et al. (2022).**The authors report that *Allium sativum* Linn (garlic) shows significant
434 hypocholesterolemic effects in patients with essential hypertension, and these effects are both dose-
435 and duration-dependent. The study suggests that garlic can function as a supportive natural therapy
436 alongside conventional lipid-lowering drugs, enhancing overall lipid profile management in
437 hypertensive patients. The authors attribute these beneficial effects to sulfur-containing compounds
438 like allicin, which are responsible for garlic's lipid-lowering and cardiovascular protective
439 properties.

440

441 **Murthy AR et al. (2000).**This clinical study evaluated the antihypertensive effect of Gokshura in
442 about 75 patients with mild to moderate essential hypertension. Patients were separated into three
443 groups, where the test groups received Gokshura extract at a dose of 3 g/day in divided doses. The
444 study showed a significant reduction in both systolic and diastolic blood pressure, along with
445 improvement in symptoms such as headache, giddiness, and insomnia. It was also observed that
446 urinary output increased, lending support to its diuretic action. The medicine was observed to be
447 safe; no major side effects were noted. Overall, Gokshura has diuretic and vasodilatory properties
448 and may be useful in managing mild to moderate hypertension.

449

450 9. FUTURE PERSPECTIVES

451 The future of polyherbal formulations in hypertension management appears promising, as advances
452 in research and technology may help overcome existing limitations. Key areas of future
453 development include the standardisation of herbal extracts, conducting clinical trials to establish
454 safety and efficacy, developing novel drug delivery systems such as tablets and capsules,
455 integrating herbal formulations with modern medicine, and identifying active phytoconstituents
456 responsible for therapeutic effects. With proper scientific investigation and clinical validation,
457 polyherbal formulations may play an important role in global healthcare[41].

458

459 10. CONCLUSION

460 Hypertension is a complex health condition influenced by multiple factors and requires a
461 comprehensive approach for effective management. Although conventional antihypertensive drugs
462 are effective in controlling blood pressure, their long-term use may be associated with side effects
463 and limitations in addressing the multiple mechanisms involved in the development of
464 hypertension.

465 Polyherbal therapy represents a promising approach that combines the therapeutic properties of
466 medicinal plants such as *Terminalia arjuna*, *Tribulus terrestris*, *Allium sativum*, and *Moringa*
467 *oleifera*. These plants contain various bioactive phytochemicals that may help regulate blood
468 pressure through different mechanisms, including vasodilation, antioxidant activity, diuretic effects,
469 and cardioprotection.

470 Synergistic interactions among the herbal constituents may improve the overall therapeutic effects
471 of polyherbal formulations. This approach may also help reduce the required dosage and minimise
472 adverse effects. Furthermore, the affordability, availability, and potential tolerability of polyherbal
473 formulations may support patient adherence to long-term treatment.

474 Despite their potential advantages, polyherbal formulations still face several challenges, such as the
475 lack of proper standardisation, insufficient clinical evidence, and regulatory issues. These
476 challenges can be overcome through systematic research, effective quality control, and well-
477 designed clinical trials. With adequate standardisation, reliable evidence of safety and efficacy, and
478 appropriate integration with conventional medicine, polyherbal formulations may become a
479 valuable complementary option for managing hypertension in the future.

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