

“Formulation and Evaluation of Herbal Tablet for Hypertension”

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ABSTRACT

The present study was undertaken to formulate and evaluate a herbal tablet containing standardized bark extract of *Terminalia arjuna* for the management of hypertension. *Terminalia arjuna* is a medicinal plant traditionally recognized for its cardioprotective and antihypertensive properties due to the presence of important phytoconstituents such as flavonoids, tannins, triterpenoids, glycosides, phenolic compounds, and arjunolic acid. The bark material was shade-dried, pulverized, and subjected to hydroalcoholic extraction using 70% ethanol by Soxhlet extraction method. From 1000 g of coarse bark powder, 185 g of dried extract was obtained with a percentage yield of 18.5%. The herbal tablets were prepared by the wet granulation method using microcrystalline cellulose, sodium starch glycolate, PVP K-30, talc, and magnesium stearate as pharmaceutical excipients. Each tablet was formulated to contain 250 mg of *Terminalia arjuna* extract with a total tablet weight of 430 mg. Pre-compression studies showed satisfactory flow properties with bulk density of $0.48 \pm 0.02 \text{ g/cm}^3$, tapped density of $0.56 \pm 0.01 \text{ g/cm}^3$, angle of repose of $27.8^\circ \pm 1.2$, Carr's index of 14.28%, and Hausner's ratio of 1.16. Post-compression evaluation confirmed acceptable pharmaceutical quality, including hardness of $6.2 \pm 0.4 \text{ kg/cm}^2$, friability of 0.62%, disintegration time of 9.4 ± 0.6 minutes, and drug content of $98.6 \pm 1.8\%$. In-vitro dissolution studies demonstrated progressive drug release with 96% release observed within 45 minutes in phosphate buffer pH 6.8. Stability studies performed under accelerated conditions ($40^\circ\text{C} \pm 2^\circ\text{C}$ / $75\% \text{ RH} \pm 5\%$) indicated no significant changes in hardness, appearance, or drug content after 15 days. The antihypertensive activity of the formulated tablets was evaluated using the L-NAME-induced hypertension model in Wistar albino rats. The hypertensive control group showed elevated systolic and diastolic blood pressure values of $165 \pm 6 \text{ mmHg}$ and $110 \pm 5 \text{ mmHg}$, respectively. Treatment with the herbal formulation produced a significant dose-dependent reduction in blood pressure. The high-dose treatment group showed systolic and diastolic blood pressure values of $130 \pm 5 \text{ mmHg}$ and $88 \pm 4 \text{ mmHg}$, respectively, which were comparable to the standard drug-treated group receiving Amlodipine. Furthermore, the formulation demonstrated improvement in lipid profile parameters by reducing total cholesterol and triglyceride levels while increasing HDL concentration. The findings of the present investigation suggest that the formulated herbal tablet of *Terminalia arjuna* possesses promising antihypertensive, cardioprotective, and hypolipidemic activities. The developed formulation may serve as a safe and effective herbal therapeutic approach for the management of hypertension and associated cardiovascular complications.

KEYWORDS

Terminalia Arjuna, Herbal Tablet, Hypertension, Wet Granulation Method, Antihypertensive Activity, Hydroalcoholic Extraction, Soxhlet Extraction, Phytoconstituents, Cardioprotective Activity, L-NAME Induced Hypertension, Dissolution Study, Herbal Formulation, Flavonoids, Triterpenoids, Blood Pressure Management.

1.INTRODUCTION

Hypertension, commonly known as high blood pressure, is one of the most widespread chronic cardiovascular disorders affecting millions of individuals worldwide. It is often described as a “silent killer” because the condition usually progresses without obvious symptoms until severe complications such as stroke, myocardial infarction, renal failure, or heart disease occur. Persistent elevation of blood pressure increases the workload on the heart and gradually damages blood vessels, leading to serious health consequences. The growing prevalence of hypertension due to unhealthy lifestyle habits, stress, obesity, excessive salt intake, and lack of physical activity has become a major public health concern globally.[1] Conventional antihypertensive drugs are widely used for the management of high blood pressure and have shown significant therapeutic effectiveness. However, prolonged use of synthetic medications is frequently associated with adverse effects including dizziness, electrolyte imbalance, fatigue, cough, and reduced patient compliance. In addition, the high cost of long-term therapy and the risk of multiple drug interactions have encouraged researchers to explore safer, economical, and more acceptable alternatives. As a result, herbal medicine has gained considerable attention for the management of hypertension and other cardiovascular disorders.[3] Medicinal plants have been utilized for centuries in traditional systems of medicine such as Ayurveda, Unani, Siddha, and Traditional Chinese Medicine. These plants contain a variety of bioactive phytoconstituents including flavonoids, alkaloids, glycosides, tannins, saponins, and phenolic compounds that possess significant therapeutic potential. Many medicinal herbs exhibit antihypertensive activity through mechanisms such as vasodilation, antioxidant action, diuretic effect, calcium channel blocking activity, and improvement of endothelial function. Due to their multi-targeted actions and comparatively lower incidence of side effects, herbal formulations are increasingly being considered as supportive or alternative therapies for hypertension management.[2] Among various herbal dosage forms, herbal tablets have emerged as a convenient and stable pharmaceutical preparation. A herbal tablet is a solid dosage form prepared by compressing powdered plant extracts or herbal ingredients into a compact form suitable for oral administration. Compared with traditional herbal preparations such as decoctions, powders, and syrups, tablets provide several advantages including accurate dosing, improved patient compliance, better stability, ease of transportation, and longer shelf life. Furthermore, tablet formulations allow proper quality control testing such as hardness, friability, weight variation, disintegration time, and dissolution studies to ensure uniformity and therapeutic consistency.[21] The formulation of herbal tablets for hypertension is based on the concept of combining traditional herbal knowledge with modern pharmaceutical technology. Herbal formulations may provide synergistic therapeutic effects because multiple phytoconstituents can act on different physiological pathways simultaneously. Some herbal components help relax vascular smooth muscles, while others reduce oxidative stress, improve circulation, or protect cardiovascular tissues. This holistic mechanism may contribute to effective and sustained blood pressure control with minimal adverse effects.

2.LITERATURE OF RESEARCH PAPER

1] Tiwari R., Mishra S., Kumar A., Danaboina G., Kalaiselvan V., Dhobi M., Raghuvanshi R.S. (2023):

Tiwari et al. reviewed the importance of plant-derived active metabolites in the treatment of hypertension. The authors discussed various phytochemicals included in the Indian Pharmacopoeia and explained their antihypertensive potential. Bioactive compounds such as flavonoids, alkaloids, glycosides, and terpenoids were reported to exhibit blood pressure-lowering activity through vasodilation, antioxidant action, calcium channel blocking, and diuretic effects. The review highlighted the need for standardization and scientific validation of herbal medicines. The authors suggested that medicinal plant metabolites provide a strong scientific basis for developing safe and effective herbal antihypertensive formulations.

2| Suradkar V.R., Wagh A.G. (2024):

Suradkar and Wagh conducted a study on the formulation and evaluation of an Ayurvedic herbal tablet for hypertension. The research focused on developing a stable and patient-friendly tablet dosage form using herbal ingredients traditionally used in cardiovascular disorders. The prepared tablets were evaluated for pharmaceutical parameters such as hardness, friability, weight variation, and disintegration time. The formulation showed satisfactory physicochemical properties and demonstrated potential antihypertensive activity. The study emphasized that combining traditional Ayurvedic knowledge with modern pharmaceutical techniques can help in the development of effective herbal tablet formulations.

3| Bhati N., Gupta N., Alam S., Bani K. (2025):

Bhati and co-workers reviewed the present and future role of herbal drugs in hypertension management. The study discussed the therapeutic importance of medicinal plants and their phytochemical constituents in regulating blood pressure. Herbal medicines were reported to possess antioxidant, vasodilatory, anti-inflammatory, and cardioprotective activities that contribute to antihypertensive effects. The authors also highlighted the growing preference for herbal therapies due to their natural origin, affordability, and lower risk of adverse effects. The review concluded that continued scientific research and clinical validation may strengthen the role of herbal medicines as alternative or complementary therapies for hypertension.

Table 1. Taxonomical Classification of Terminalia arjuna:

S. NO.	TAXONOMICAL	CLASSIFICATION
1.	Kingdom	Plantae
2.	Subkingdom	Tracheobionta
3.	Division	Magnoliophyta
4.	Class	Magnoliopsida
5.	Order	Myrtales
6.	Family	Combretaceae
7.	Genus	<i>Terminalia</i>
8.	Species	<i>Terminalia arjuna</i>
Common Names		Arjuna, Arjun Tree, White Marudah, Arjun Bark, Dhavala, Kakubha

3.MORPHOLOGICAL CHARACTERISTICS OF TERMINALIA ARJUNA

Terminalia arjuna is a large medicinal tree belonging to the family Combretaceae. It is an evergreen to semi-deciduous plant that commonly grows in tropical and subtropical regions. Under suitable environmental conditions, the tree can attain a height of about 20–30 meters. It possesses a strong and straight trunk with a broad crown formed by widely spreading branches. The tree is commonly distributed near riverbanks, forests, and moist areas where sufficient water is available for growth.[3] The outer surface of the tree appears smooth and greyish in color, while older trees may develop slightly rough patches. The leaves are simple, oblong, and arranged oppositely or sub-oppositely on the branches. They are dark green on the upper surface and pale beneath. The flowers are small, pale yellow to greenish-white, and usually appear during the months of March to June. The fruits are woody, fibrous, and characterized by five hard wings, which help in identification of the species. Fruiting generally occurs from September to November.[11] The plant is widely recognized for its medicinal importance, especially its bark, which is extensively used in traditional medicine for cardiovascular disorders. Various morphological characteristics of *Terminalia arjuna* play an important role in its identification, authentication, and pharmacognostic evaluation.[33]

3.1.Bark:

The bark of *Terminalia arjuna* is considered the most therapeutically valuable part of the plant and possesses several characteristic morphological features. The outer bark is smooth and grey to pinkish-

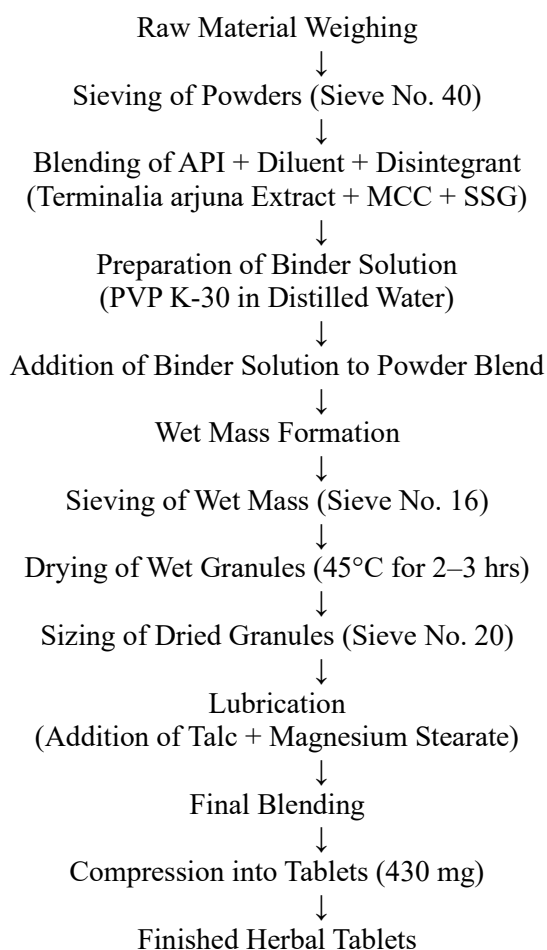
grey in color in younger trees, while mature bark becomes comparatively darker. One of the most distinctive features of the bark is its exfoliating nature, as it peels off naturally in thin flakes or irregular patches. Removal of the outer layer exposes a fresh inner surface that appears reddish or pinkish-brown.[24] The bark is moderately thick and fibrous in texture. On breaking, it shows a short and slightly fibrous fracture. It has a mild odor and a distinctly astringent taste due to the presence of tannins and other phenolic constituents. The bark is generally collected, shade-dried, and powdered before being used for medicinal or pharmaceutical purposes.[23] The smooth grey outer surface, exfoliating patches, and reddish inner bark are considered important identifying features during pharmacognostic examination and quality evaluation of *Terminalia arjuna* bark.[14]

3.2.Geographical Distribution:

Terminalia arjuna is an important medicinal tree widely distributed throughout the Indian subcontinent, particularly in tropical and subtropical regions. The plant commonly grows along riverbanks, streams, and moist deciduous forests where adequate water supply and fertile soil support its healthy development. It is naturally found in several Indian states, including Madhya Pradesh, Uttar Pradesh, Bihar, Maharashtra, West Bengal, Tamil Nadu, Karnataka, and Kerala. In Madhya Pradesh, *Terminalia arjuna* is frequently observed in forest regions, roadside plantations, herbal gardens, and areas near water bodies. The climatic conditions of Bhopal, including moderate rainfall, warm temperature, and suitable soil composition, favor the growth and propagation of this species.

4.METHODOLOGY

[WET GRANULATION METHOD]



5.FORMULATION

5.1.Formulation of Herbal Tablet of Terminalia arjuna for Hypertension:

The bark of Terminalia arjuna is rich in pharmacologically active constituents such as arjunolic acid, arjunic acid, flavonoids, tannins, and triterpenoids, which are responsible for its cardioprotective and antihypertensive activities. The main objective of the present formulation is to develop a standardized, stable, and patient-friendly herbal tablet containing a quantified extract of Terminalia arjuna, ensuring consistent quality, safety, and therapeutic efficacy.[6]



[FIGURE 1. FRESH BARK OF TERMINALIA ARJUNA]

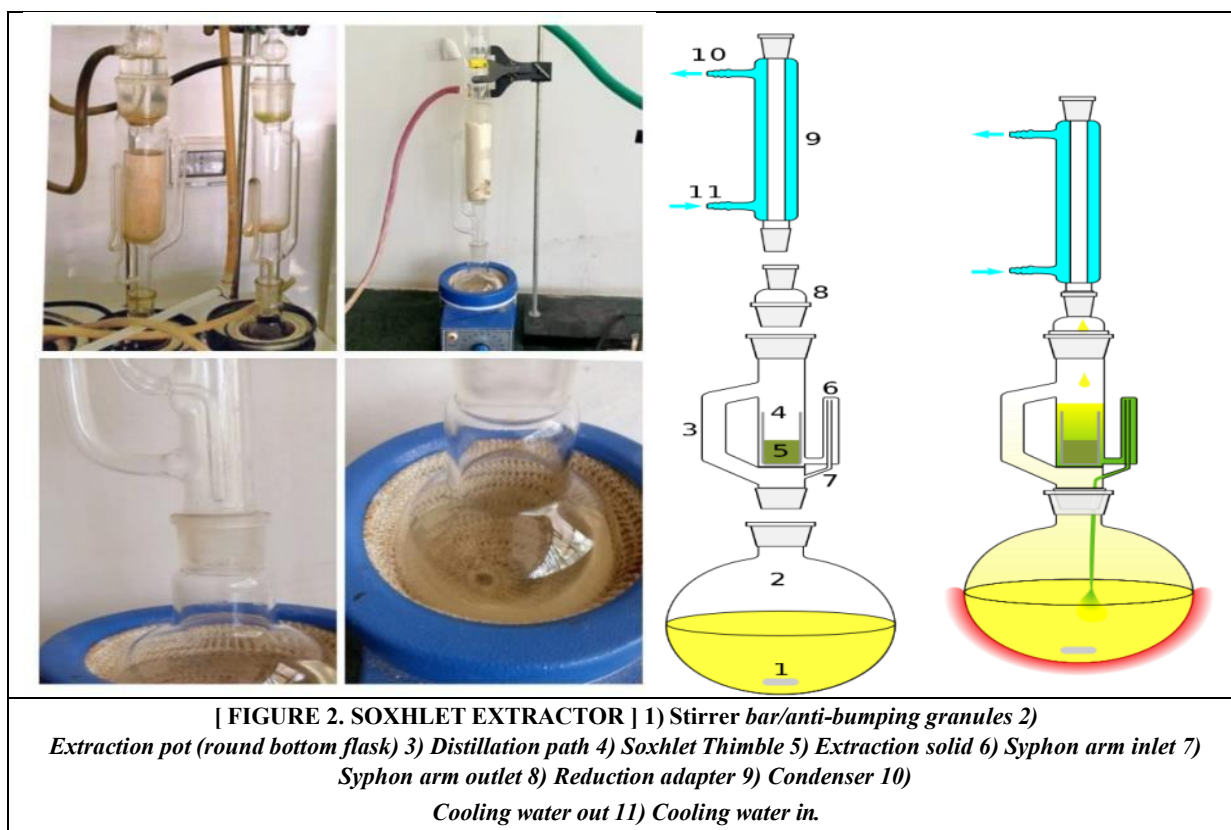
5.2.Preparation of Extract:

A) Extraction Method (Hydroalcoholic Extraction):

The hydroalcoholic extraction method was selected to obtain a broad spectrum of phytoconstituents from the bark of Terminalia arjuna. This method is widely used due to its efficiency in extracting both polar and moderately non-polar compounds.[14]

5.3.Preparation of Plant Extract:

The freshly collected bark of Terminalia arjuna was processed for extraction of its bioactive constituents. Initially, the bark was washed properly and cut into small pieces for easy drying. The material was shade-dried at room temperature to protect sensitive phytochemicals from degradation caused by direct sunlight and excessive heat. After complete drying, the bark was subjected to pulverization.[32] Pulverization is a mechanical process in which solid materials are reduced into fine particles or coarse powder using suitable grinding equipment. The dried bark was ground with the help of a mechanical grinder to obtain a coarse powder, which served as the raw material for extraction. The powdered bark contains several important phytoconstituents such as flavonoids, tannins, glycosides, triterpenoids, and antioxidant compounds that are responsible for its therapeutic activity. Extraction was carried out using a suitable solvent such as ethanol, water, or hydroalcoholic solution. A measured quantity of the powdered material was transferred into a Soxhlet apparatus or maceration vessel containing the selected solvent. During extraction, the solvent penetrated the plant tissues and dissolved the active constituents present in the bark powder.[17] After completion of the extraction process, the mixture was filtered to separate the liquid extract from insoluble plant residues. The filtrate obtained was concentrated by evaporating the solvent under controlled temperature using a rotary evaporator or water bath. The concentrated extract was then dried and stored in an airtight container for further formulation and evaluation studies.



- **Raw material:** Dried bark powder
- **Solvent:** 70% ethanol
- **Method:** Soxhlet extraction (6–8 hours)
- **Temperature:** 60–70°C
- **Filtration:** Whatman filter paper
- **Concentration:** Rotary evaporator
- **Drying:** Vacuum oven at 40°C

Table 2. Major Phytochemical Constituents of *Terminalia arjuna* Bark:

S.NO.	PHYTOCHEMICAL CLASS	(%)IN DRIED BARK	THERAPEUTIC SIGNIFICANCE
1	Tannins	15–25%	Antioxidant, cardioprotective, vascular strengthening
2	Triterpenoids (Arjunolic acid, Arjunic acid, Arjungenin)	1–3%	ACE inhibition, vasorelaxant activity
3	Flavonoids (Arjunone, Luteolin, Quercetin derivatives)	0.5–2%	Antioxidant, endothelial protection

4	Saponins	2–4%	Hypolipidemic, improves cardiac function
5	Glycosides	1–2%	Cardioprotective effects
6	Phytosterols (β -sitosterol)	0.3–0.8%	Lipid-lowering activity
7	Minerals (Calcium, Magnesium, Zinc)	2–4%	Support cardiovascular health
8	Carbohydrates	10–15%	Structural component
9	Proteins & Amino acids	3–5%	Nutritional support
10	Phenolic compounds (Total phenolics)	5–10%	Strong antioxidant activity

Table 3. Percentage Yield:

S.NO.	PARAMETER	VALUE
1	Weight of coarse powder	1000 g
2	Weight of dried extract obtained	185 g
3	Percentage yield	18.5%

5.3.1. Wet Granulation Method for Herbal Tablet:**Step 1: Blending:**

- Accurately weigh 7.50 g of T. arjuna extract, 3.60 g microcrystalline cellulose, and 0.75 g sodium starch glycolate.[28]
- Pass all powders through sieve no. 40 to ensure uniform particle size.
- Transfer into a clean mortar or planetary mixer.
- Mix thoroughly for 10–15 minutes to achieve uniform distribution of the active ingredient.

Step 2: Preparation of Binder Solution:

- Accurately weigh 0.60 g PVP K-30.
- Dissolve in approximately 5–7 mL of distilled water to form a clear binder solution.
- Stir until completely dissolved.

Step 3: Granulation:

- Add the binder solution slowly to the powder blend with continuous mixing.
- Mix until a cohesive, damp mass is formed.[15]
- Avoid overwetting to prevent hard granules.

Step 4: Sieving:

- Pass the wet mass through sieve no. 16 to obtain uniform wet granules.
- Spread granules evenly on a stainless steel tray.

Step 5: Drying:

- Dry the granules in a hot air oven at 45°C for 2–3 hours.
- Ensure moisture content is reduced to below 2–3%.
- After drying, pass granules again through sieve no. 20 to break lumps.

Step 6: Lubrication:

- Add 0.30 g talc and 0.15 g magnesium stearate to the dried granules.
- Mix gently for 3–5 minutes to ensure uniform lubrication.
- Avoid excessive mixing to prevent reduction in tablet hardness.

Step 7: Compression:

- Set the tablet compression machine for a target weight of 430 mg.
- Adjust hardness to approximately 5–7 kg/cm².
- Compress granules using appropriate punches (usually 8–10 mm round punch).
- Collect 30 tablets and store in an airtight container.

Final Batch Summary:

- Total blend prepared: ~12.90 g
- Number of tablets obtained: 30
- Average tablet weight: 430 mg
- Expected hardness: 5–7 kg/cm²
- Disintegration time: <15 minutes
-

Table 4. Formulation of Herbal Tablet of Terminalia arjuna for Hypertension Active ingredient: Terminalia arjuna bark extract:

S.NO.	INGREDIENT	QUANTITY PER TABLET (MG)	30 TABLETS (MG)	QUANTITY (G)
1	<i>T. arjuna</i> extract	250 mg	7500 mg	7.50 g
2	Microcrystalline cellulose	120 mg	3600 mg	3.60 g
3	Sodium starch glycolate	25 mg	750 mg	0.75 g
4	PVP K-30	20 mg	600 mg	0.60 g
5	Talc	10 mg	300 mg	0.30 g
6	Magnesium stearate	5 mg	150 mg	0.15 g
7	Total	430 mg	12,900 mg	12.90 g

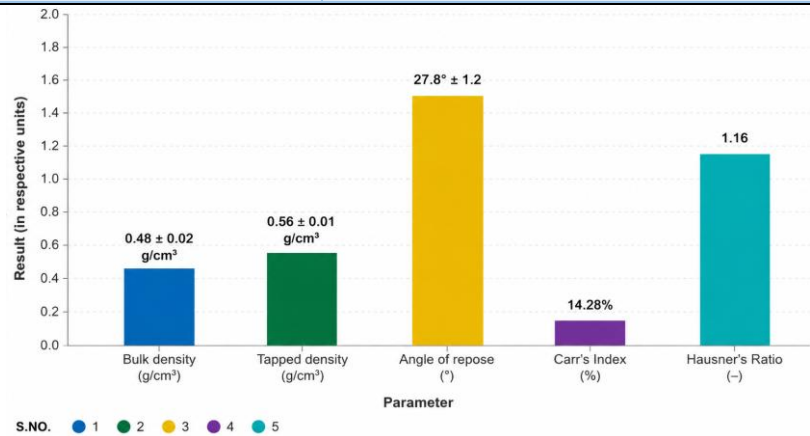


FIGURE 3. HERBAL TABLET OF TERMINALIAARJUNA]

6.EVALUATION OF TABLETS:

Table 5. Pre-Compression Parameters:

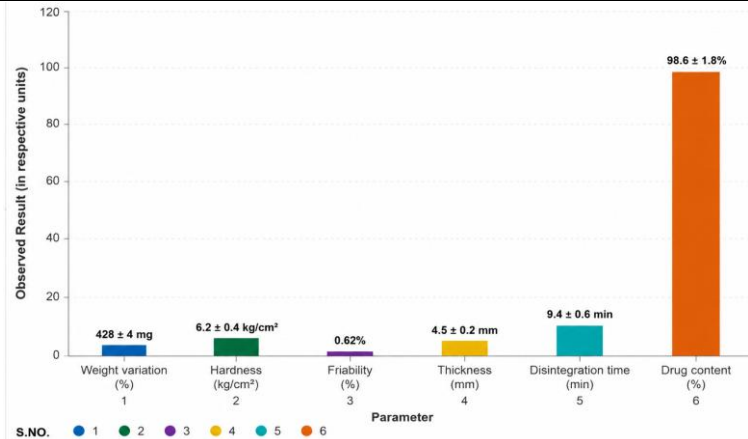
S.NO.	PARAMETER	RESULT
1	Bulk density	0.48 ± 0.02 g/cm³
2	Tapped density	0.56 ± 0.01 g/cm³
3	Angle of repose	27.8° ± 1.2
4	Carr's Index	14.28%
5	Hausner's Ratio	1.16



[FIGURE 4. Pre-Compression Parameters: [1] Bulk density [2] Tapped density [3] Angle of repose [4] Angle of repose [5] Hausner's Ratio]

Table 6. Post-Compression Evaluation:

S.NO.	PARAMETER	PHARMACOPOEIAL LIMIT	OBSERVED RESULT (MEAN ± SD, N=20)
1	Weight variation	±5%	428 ± 4 mg
2	Hardness	4–8 kg/cm²	6.2 ± 0.4 kg/cm²
3	Friability	<1%	0.62%
4	Thickness	—	4.5 ± 0.2 mm
5	Disintegration time	<15 min	9.4 ± 0.6 min
6	Drug content	90–110%	98.6 ± 1.8%



[FIGURE 5. Post-Compression Evaluation: [1] Weight variation [2] Hardness [3] Friability [4] Thickness [5] Disintegration time [6] Drug content]

6.1. In-Vitro Dissolution Study:

- Medium: Phosphate buffer pH 6.8
- Apparatus: USP Type II (Paddle)
- RPM: 50
- Temperature: $37 \pm 0.5^\circ\text{C}$

Table 7. % Drug Release Dissolution Study:

S.NO.	TIME (MIN)	% DRUG RELEASE
1	5	28%
2	10	46%
3	20	68%
4	30	85%
5	45	96%

6.2. Stability Study:

Condition: $40^\circ\text{C} \pm 2^\circ\text{C}$ / $75\% \text{ RH} \pm 5\%$.

Table 8. Stability Study with Parameter:

S.NO.	PARAMETER	INITIAL	AFTER 15 DAYS
1	Hardness	6.2 kg/cm ²	6.0 kg/cm ²
2	Drug content	98.6%	97.8%
3	Appearance	No change	No change

7. DOSING:

Based on literature reports and traditional usage, the therapeutic dose of Terminalia arjuna bark extract for cardiovascular support ranges between 250–500 mg per day. For this study:

- Selected dose per tablet: 250 mg standardized extract
- Administration: Twice daily

Table 9. Experimental Animals Details:

S.NO.	PARAMETER	DESCRIPTION
1	Species	Wistar albino rats
2	Body Weight	180–220 g
3	Sex	Either sex
4	Total Number of Animals	30
5	Housing Conditions	Standard laboratory conditions
6	Light/Dark Cycle	12 h light / 12 h dark
7	Temperature	$25 \pm 2^\circ\text{C}$
8	Ethical Approval	Conducted as per CPCSEA guidelines

Table 10. Induction of Hypertension:

S.NO.	PARAMETER	DESCRIPTION
1	Experimental Model	L-NAME-induced hypertension model[4]
2	Chemical Used	L-NAME (N ω -Nitro-L-arginine methyl ester)
3	Dose	40 mg/kg/day
4	Route of Administration	Oral
5	Duration of Treatment	21 days
6	Mechanism of Induction	Inhibition of nitric oxide synthesis leading to increased vascular resistance and elevated blood pressure

Table 11. Experimental Grouping (n = 6 per group):

S.NO.	GROUP	TREATMENT	DOSE
1	Group I	Normal Control	Normal saline
2	Group II	Hypertensive Control	L-NAME only
3	Group III	Standard	Amlodipine 5 mg/kg
4	Group IV	Test Low Dose	<i>T. arjuna</i> tablet (250 mg/kg)
5	Group V	Test High Dose	<i>T. arjuna</i> tablet (500 mg/kg)

7.1.Effect on Blood Pressure:

7.1.1.Systolic blood pressure:

The systolic blood pressure (SBP) of all experimental groups was measured on Day 0 and Day 21 to evaluate the antihypertensive potential of the formulated herbal tablet.

On Day 0, the systolic blood pressure values of all groups were found to be nearly similar, ranging between 118 ± 3 mmHg and 121 ± 4 mmHg. This indicates that there was no significant difference among the groups prior to the induction of hypertension, confirming uniform baseline conditions for the experiment. After 21 days of treatment, the normal control group maintained almost constant systolic blood pressure (120 ± 4 mmHg), indicating stable physiological conditions throughout the study period. In contrast, the hypertensive control group showed a substantial increase in systolic blood pressure, reaching 165 ± 6 mmHg, which confirms the successful induction of hypertension. The standard drug-treated group exhibited a marked reduction in systolic blood pressure compared with the hypertensive control group, with a recorded value of 128 ± 5 mmHg. This demonstrates the effectiveness of the standard antihypertensive therapy used in the experiment.

The test groups treated with the herbal formulation also showed a noticeable decrease in systolic blood pressure. The test low dose group recorded a value of 140 ± 6 mmHg, indicating a moderate antihypertensive effect. Meanwhile, the test high dose group demonstrated a greater reduction, with systolic blood pressure decreasing to 130 ± 5 mmHg.

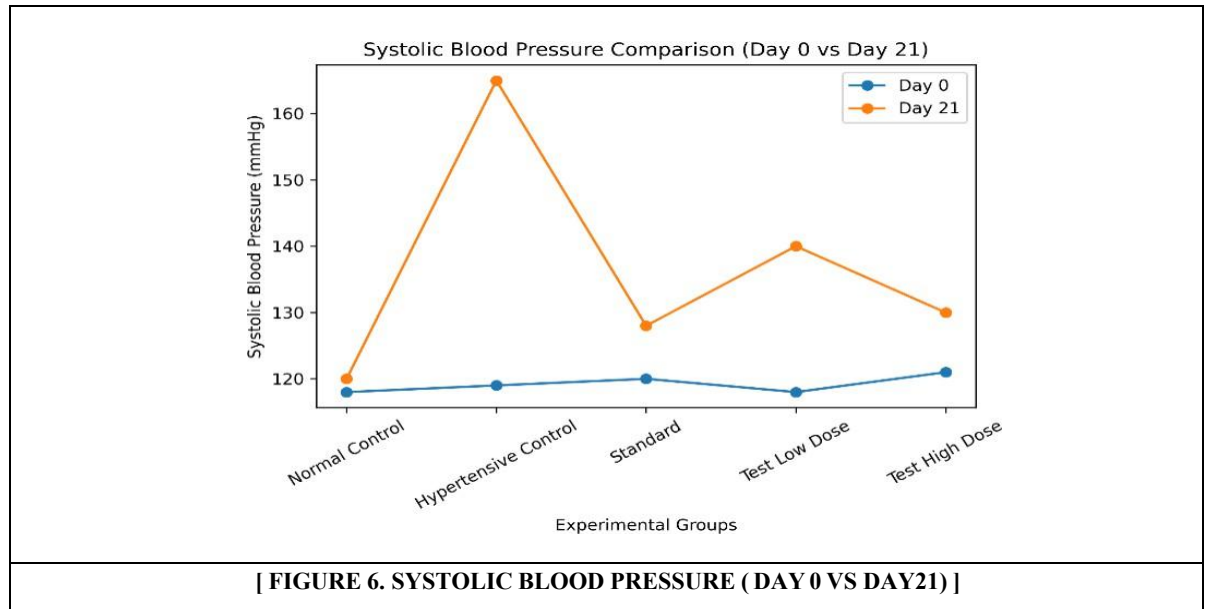


Table 12. Systolic Blood Pressure (mmHg):

S.NO.	GROUP	DAY 0	DAY 21
1	Normal Control	118 ± 3	120 ± 4
2	Hypertensive Control	119 ± 4	165 ± 6

3	Standard	120 ± 3	128 ± 5
4	Test Low Dose	118 ± 5	140 ± 6
5	Test High Dose	121 ± 4	130 ± 5

7.1.2.Diastolic Blood Pressure:

The effect of the formulated herbal tablet on diastolic blood pressure (DBP) was evaluated in experimental groups over a period of 21 days. On Day 0, all groups showed nearly similar diastolic blood pressure values ranging from 77 ± 4 mmHg to 80 ± 3 mmHg, indicating that there was no significant difference among the groups before the induction of hypertension. After 21 days, the normal control group maintained stable blood pressure values (80 ± 4 mmHg), confirming normal physiological conditions throughout the experimental period. In contrast, the hypertensive control group exhibited a marked increase in diastolic blood pressure, reaching 110 ± 5 mmHg, which confirms the successful induction of hypertension. The standard treatment group showed a considerable reduction in blood pressure compared with the hypertensive control group, recording a value of 85 ± 4 mmHg, which indicates the effectiveness of the standard antihypertensive treatment. In the test groups, the herbal tablet demonstrated a dose-dependent antihypertensive effect. The test low dose group showed a moderate reduction in diastolic blood pressure (95 ± 5 mmHg), whereas the test high dose group exhibited a greater reduction (88 ± 4 mmHg). This suggests that the higher dose of the herbal formulation was more effective in controlling elevated blood pressure.

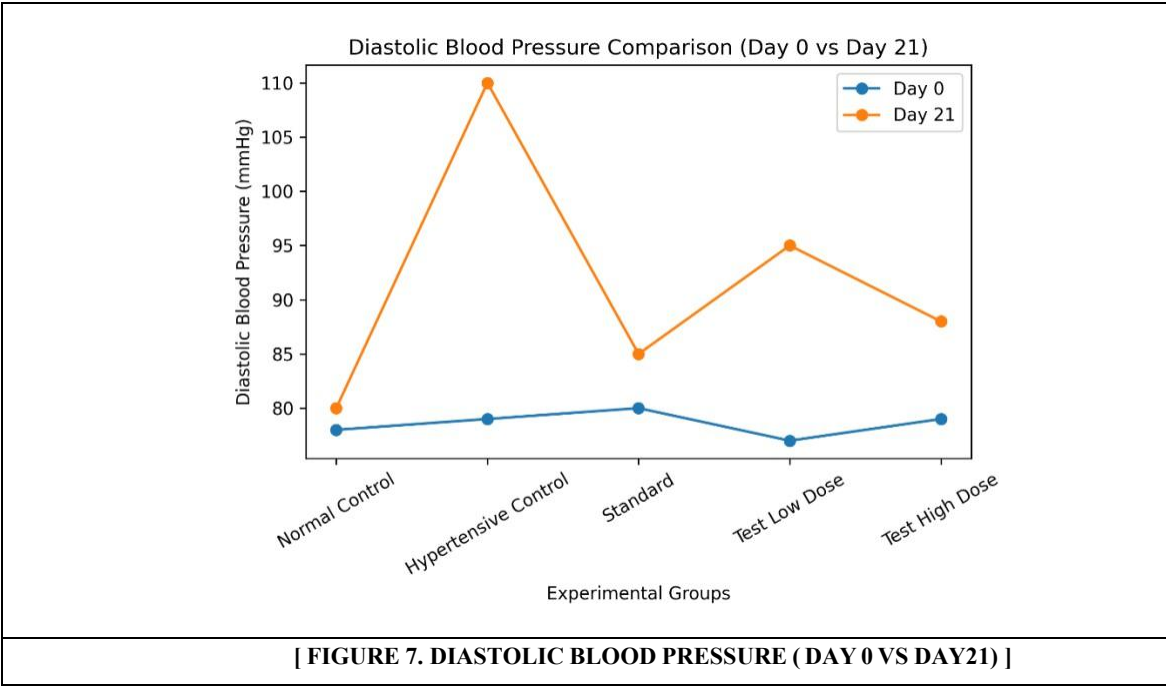


Table 13. Diastolic Blood Pressure (mmHg):

S.NO.	GROUP	DAY 0	DAY 21
1	Normal Control	78 ± 3	80 ± 4
2	Hypertensive Control	79 ± 4	110 ± 5
3	Standard	80 ± 3	85 ± 4
4	Test Low Dose	77 ± 4	95 ± 5
5	Test High Dose	79 ± 3	88 ± 4

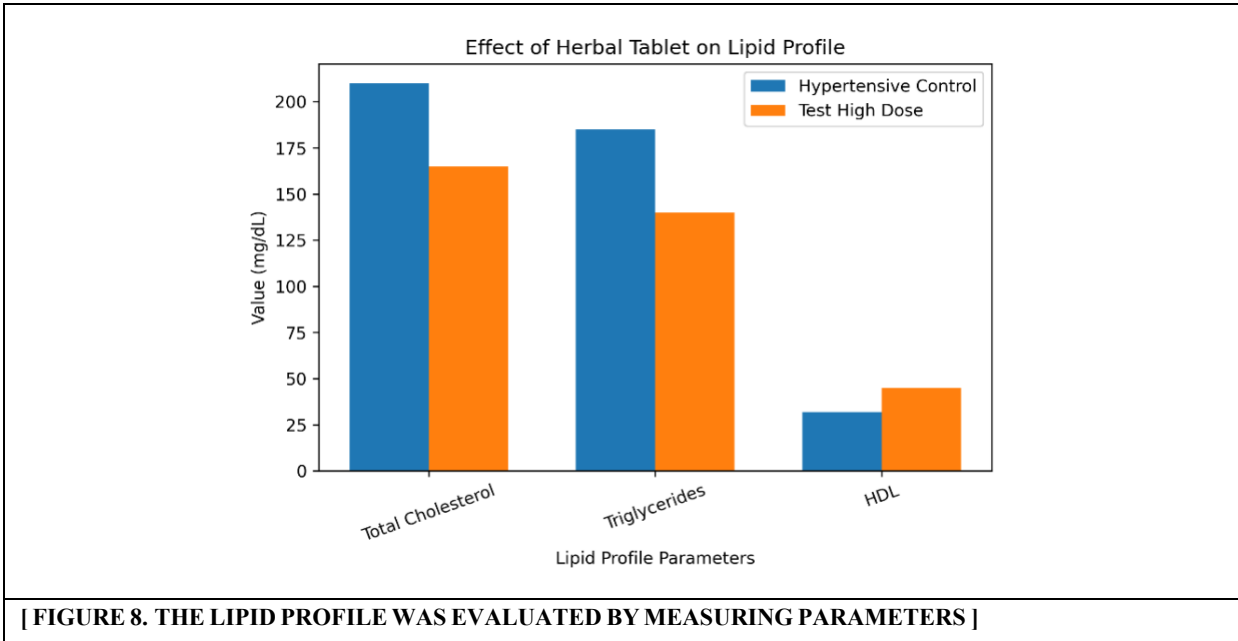
7.2.Effect on Lipid Profile:

The effect of the formulated herbal tablet on the lipid profile was evaluated by measuring total cholesterol, triglycerides, and high-density lipoprotein (HDL) levels in the experimental groups. The

results obtained are presented in Table 14.[13] The hypertensive control group showed elevated levels of total cholesterol and triglycerides, with values recorded as 210 ± 10 mg/dL and 185 ± 9 mg/dL, respectively. These increased lipid levels are commonly associated with hypertension and may contribute to cardiovascular complications. In addition, the HDL level in this group was relatively low (32 ± 3 mg/dL), indicating an unfavorable lipid profile. The test high-dose group treated with the herbal tablet demonstrated a noticeable improvement in lipid parameters. The level of total cholesterol decreased to 165 ± 8 mg/dL, while triglyceride levels were reduced to 140 ± 7 mg/dL. Furthermore, the HDL level increased to 45 ± 4 mg/dL, suggesting a beneficial effect on the lipid profile. The reduction in total cholesterol and triglycerides, along with the increase in HDL levels, indicates that the herbal formulation may possess hypolipidemic activity. These findings suggest that the herbal tablet not only helps in controlling blood pressure but also contributes to improving lipid metabolism, which may reduce the risk of cardiovascular complications associated with hypertension.

Table 14. Cholesterol, Triglycerides, and High-Density Lipoprotein:

S.NO.	PARAMETER	HYPERTENSIVE CONTROL	TEST HIGH DOSE
1	Total Cholesterol	210 ± 10 mg/dL	165 ± 8 mg/dL
2	Triglycerides	185 ± 9 mg/dL	140 ± 7 mg/dL
3	HDL	32 ± 3 mg/dL	45 ± 4 mg/dL



8.RESULTS & DISCUSSION

The present study focused on the development and evaluation of a herbal tablet formulated using a standardized extract of *Terminalia arjuna* bark as the principal active ingredient. Each tablet was designed to contain 250 mg of the extract, while the total tablet weight was standardized to 430 mg to ensure uniformity, accurate dosing, and ease of administration. For the laboratory-scale preparation of 30 tablets, precise quantities of all ingredients were calculated and weighed to maintain batch consistency and minimize processing loss. A total of 7.50 g of *T. arjuna* extract was used as the active component. Microcrystalline cellulose (3.60 g) was incorporated as a diluent to improve bulk, flow properties, and compressibility of the formulation. Sodium starch glycolate (0.75 g) was added as a superdisintegrant to enhance rapid tablet disintegration in gastrointestinal fluids. Polyvinylpyrrolidone K-30 (0.60 g) was used as a binder to ensure proper granule formation and mechanical strength. Talc

(0.30 g) was included as a glidant to improve powder flow, while magnesium stearate (0.15 g) acted as a lubricant to reduce friction during compression. The total weight of the formulation for 30 tablets was 12.90 g. The antihypertensive activity of the formulated herbal tablets was evaluated using the L-NAME induced hypertension model in experimental animals. This model is widely accepted for studying cardiovascular agents because L-NAME inhibits nitric oxide synthase, leading to reduced nitric oxide production. The resulting endothelial dysfunction causes vasoconstriction, increased peripheral resistance, and a sustained elevation in blood pressure, thereby mimicking essential hypertension. At baseline (Day 0), all experimental groups showed comparable systolic and diastolic blood pressure values, confirming uniform physiological conditions before induction. After 21 days of L-NAME administration, the hypertensive control group exhibited a significant increase in blood pressure, with systolic and diastolic values recorded at 165 ± 6 mmHg and 110 ± 5 mmHg, respectively. This confirmed successful induction of hypertension.[4]

The standard drug group treated with amlodipine showed a significant protective effect, with systolic and diastolic pressures maintained at 128 ± 5 mmHg and 85 ± 4 mmHg, respectively, demonstrating the validity of the experimental model. Treatment with the formulated *Terminalia arjuna* tablets produced a dose-dependent antihypertensive effect. At a dose of 250 mg/kg, a moderate reduction in blood pressure was observed, with systolic pressure reduced to 140 ± 6 mmHg and diastolic pressure to 95 ± 5 mmHg. A more pronounced effect was recorded at 500 mg/kg, where systolic pressure decreased to 130 ± 5 mmHg and diastolic pressure to 88 ± 4 mmHg. These results indicate that the herbal formulation exhibits significant antihypertensive potential, approaching the efficacy of the standard drug at higher doses. The observed activity may be attributed to the presence of bioactive phytoconstituents such as flavonoids, tannins, triterpenoids, and arjunolic acid in *Terminalia arjuna*. These compounds are known to exert vasodilatory, antioxidant, and cardioprotective effects, which collectively contribute to the regulation of blood pressure and improvement of endothelial function.

9.CONCLUSION

The present study successfully demonstrated the formulation and evaluation of a herbal tablet prepared from the bark extract of *Terminalia arjuna* for the management of hypertension. The wet granulation method employed for tablet preparation yielded a dosage form with satisfactory pharmaceutical properties, including acceptable hardness, uniform weight variation, adequate disintegration time, and good mechanical strength. These results confirm that the developed formulation is physically stable, uniform, and suitable for oral administration. The *in vivo* evaluation using the L-NAME-induced hypertensive rat model clearly established the antihypertensive potential of the formulated herbal tablet. Administration of L-NAME produced a significant elevation in both systolic and diastolic blood pressure due to inhibition of nitric oxide synthesis and increased peripheral vascular resistance. Treatment with the *Terminalia arjuna* tablet produced a significant and dose-dependent reduction in elevated blood pressure levels. The higher dose showed effects comparable to the standard antihypertensive drug, indicating notable pharmacological efficacy. The observed antihypertensive activity may be attributed to the presence of bioactive phytoconstituents such as flavonoids, triterpenoids, tannins, and phenolic compounds present in *Terminalia arjuna*. These compounds are known to exert antioxidant effects, improve endothelial function, enhance vascular elasticity, and possibly modulate pathways involved in blood pressure regulation, thereby contributing collectively to the overall therapeutic effect. The study supports that *Terminalia arjuna* bark extract-based herbal tablets have promising potential as a natural and effective approach for the management of hypertension. However, further detailed clinical studies are required to confirm long-term safety, efficacy, and therapeutic applicability in human subjects.

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11.ABBREVIATION

S. N O.	A.B	FULL FORM	S. N O.	A.B	FULL FORM
1	ACE	Angiotensin Converting Enzyme	16	mm	Millimeter
2	API	Active Pharmaceutical Ingredient	17	mmHg	Millimeter of Mercury
3	BP	Blood Pressure	18	PVP K-30	Polyvinylpyrrolidone K-30
4	CPCSEA	Committee for the Purpose of Control and Supervision of Experiments on Animals	19	RH	Relative Humidity
5	DBP	Diastolic Blood Pressure	20	RPM	Revolutions Per Minute
6	g	Gram	21	SBP	Systolic Blood Pressure
7	HDL	High Density Lipoprotein	22	SD	Standard Deviation
8	HPLC	High Performance Liquid Chromatography	23	SSG	Sodium Starch Glycolate
9	hr	Hour	24	T. arjuna	Terminalia arjuna
10	kg/cm²	Kilogram per Square Centimeter	25	USP	United States Pharmacopeia
11	L-NAME	N ω -Nitro-L-Arginine Methyl Ester	26	UV	Ultraviolet
12	MCC	Microcrystalline Cellulose	27	WHO	World Health Organization
13	mg	Milligram	28	w/v	Weight per Volume
14	mg/dL	Milligram per Deciliter	29	°C	Degree Celsius
15	min	Minute	30	%	Percentage

12. REFERENCES

1. Amalraj A, Gopi S. Medicinal properties of Terminalia arjuna: A review. *Journal of Traditional and Complementary Medicine*. 2017;7(1):65–78.
2. Anonymous. *The Ayurvedic Pharmacopoeia of India*. New Delhi: Government of India; 2007.
3. Anonymous. *The Wealth of India: Raw Materials*. New Delhi: CSIR; 2003.
4. Bhandari U, Jain N, Pillai KK. Effect of Terminalia arjuna in experimental hypertension models. *Journal of Ethnopharmacology*. 2008;115:46–52.
5. Bhandari U, Sharma JN. Protective effect of Terminalia arjuna in cardiovascular diseases. *Journal of Medicinal Plants Research*. 2011;5:221–227.
6. Chander R, Singh K, Khanna AK. Cardioprotective activity of Terminalia arjuna bark extract. *Phytotherapy Research*. 2004;18:73–75.
7. Dwivedi S. Clinical efficacy of Terminalia arjuna in chronic stable angina. *Indian Heart Journal*. 1997;49:507–510.
8. Dwivedi S. Effect of Terminalia arjuna on blood pressure and heart function. *Indian Heart Journal*. 2002;54:441–444.
9. Dwivedi S. Terminalia arjuna and cardiovascular disorders: Clinical evidence. *Indian Journal of Pharmacology*. 2001;33:349–355.
10. Dwivedi S. Terminalia arjuna Wight & Arn.—A useful drug for cardiovascular disorders. *Journal of Ethnopharmacology*. 2007;114(2):114–129.
11. Dwivedi S, Udupa N. Terminalia arjuna: Pharmacognosy, phytochemistry, pharmacology and clinical use. *Phytotherapy Research*. 1989;3(4):121–129.
12. Evans WC. *Trease and Evans Pharmacognosy*. 16th ed. London: Elsevier; 2009.
13. Gupta R, Kesari AN. Hypolipidemic effect of Terminalia arjuna bark. *Indian Journal of Experimental Biology*. 2004;42:339–343.
14. Gupta R, Sharma AK. Antioxidant activity of Terminalia arjuna bark extract. *Journal of Herbal Medicine*. 2012;2:25–30.
15. Gupta S, et al. Evaluation of herbal formulations in hypertension. *International Journal of Pharmaceutical Sciences Review and Research*. 2016;38:56–60.
16. Harborne JB. *Phytochemical Methods*. London: Chapman and Hall; 1998.
17. Karthikeyan K, Bai BR, Devaraj SN. Cardioprotective effect of Terminalia arjuna bark extract. *Journal of Ethnopharmacology*. 2003;89:217–221.
18. Katzung BG. *Basic and Clinical Pharmacology*. 14th ed. New York: McGraw Hill; 2018.
19. Khan MA, et al. Herbal medicines in cardiovascular therapy. *Journal of Herbal Medicine*. 2015;5:23–30.
20. Kirtikar KR, Basu BD. *Indian Medicinal Plants*. Dehradun: International Book Distributors; 2005.
21. Kokate CK, Purohit AP, Gokhale SB. *Pharmacognosy*. Pune: Nirali Prakashan; 2018.
22. Kumar V, et al. Cardioprotective herbal drugs used in Ayurveda. *Journal of Pharmacognosy and Phytochemistry*. 2018;7:124–129.
23. Manisha M, Dixit M. Systematic review on Terminalia arjuna phytoconstituents and pharmacological actions. *International Journal of AYUSH*. 2025.
24. Mishra S, et al. Phytochemical and pharmacological review of Terminalia arjuna. *Asian Journal of Pharmaceutical Research*. 2019;9:43–50.
25. Mukherjee PK. *Quality Control of Herbal Drugs*. New Delhi: Business Horizons; 2019.
26. Nadkarni AK. *Indian Materia Medica*. Mumbai: Popular Prakashan; 2002.
27. Rang HP, Dale MM, Ritter JM. *Pharmacology*. 8th ed. Elsevier; 2016.
28. Sharma A, et al. Evaluation of antihypertensive activity of polyherbal formulation containing

- Terminalia arjuna. Journal of Ayurveda and Integrative Medicine. 2018.
29. Sharma PC, Yelne MB, Dennis TJ. Database on Medicinal Plants Used in Ayurveda. New Delhi: CCRAS; 2005.
 30. Sharma PV. Dravyaguna Vijnana. Varanasi: Chaukhamba Bharati Academy; 2005.
 31. Sharma S, Asija R, Kumawat RS, et al. Study of antihyperlipidemic activity of Terminalia arjuna formulations. Journal of Biomedical and Pharmaceutical Research. 2014.
 32. Singh N, Kumar D, et al. Pharmacological evaluation of Terminalia arjuna bark extract. Pharmacognosy Reviews. 2008;2:162–168.
 33. Singh RB, Niaz MA. Clinical effects of Terminalia arjuna in coronary artery disease. Journal of the Association of Physicians of India. 2003;51:403–405.
 34. Singh N, et al. Antioxidant and cardioprotective activity of Terminalia arjuna. Pharmacognosy Journal. 2010;2:20–25.
 35. Trease GE, Evans WC. Pharmacognosy. 16th ed. London: Saunders Elsevier; 2009.
 36. Vyas M, et al. Identification of antihypertensive phytoconstituents in Terminalia arjuna. Current Pharmaceutical Design. 2026.
 37. World Health Organization. WHO Guidelines for Herbal Medicines. Geneva: WHO; 2013.
 38. Gupta RK, et al. Cardioprotective herbal drugs and their therapeutic potential. International Journal of Pharmaceutical Sciences. 2015.
 39. Sharma R, et al. Herbal medicines for hypertension management. International Journal of Pharmacy and Pharmaceutical Sciences. 2017.
 40. Bhandari P, et al. Evaluation of natural products for cardiovascular protection. Journal of Natural Medicines. 2018.

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