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Kavita Nesur
Department of Pharmacology, BLDEA's SSM College of Pharmacy and Research Centre, Vijayapur, Karnataka, India

Afrozali Nadaf
Department of Pharmacology, BLDEA's SSM College of Pharmacy and Research Centre, Vijayapur, Karnataka, India

Sanjana Mareguddi
Department of Pharmaceutical Chemistry, BLDEA's SSM College of Pharmacy and Research Centre, Vijayapur, Karnataka, India

Corresponding Author:
Kavita Nesur
Department of Pharmacology, BLDEA's SSM College of Pharmacy and Research Centre, Vijayapur, Karnataka, India

A review on the phytochemistry, pharmacology, and therapeutic potentials of *Cissus quadrangularis* (Asthi Shrinkhala)

Kavita Nesur, Afrozali Nadaf and Sanjana Mareguddi

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Abstract
Cissus quadrangularis L. (Asthishrinkhala) is a member of the Vitaceae family and is a native medicinal plant found in India. It is used comprehensively as a medicinal herb in most of the tropical regions in various parts of the country. It has been recommended in old Ayurvedic texts by Bhavaprakash and Chakradutta as an overall tonic, particularly for bone-related disorders patients, and has high potential against a few illnesses. The review article on Asthishrinkhala provides a comprehensive overview of its ethnic and traditional description, morphology, phytochemistry, pharmacological properties, and toxicological profile. It also discusses the advances, trends, and future research perspectives related to this plant. Furthermore, the article highlights the importance of traditional medicines and herbal-based treatments globally and emphasises the need for updating and integrating research findings in this field. Overall, the review article serves as a valuable resource for researchers and practitioners interested in Asthishrinkhala and its potential therapeutic uses.

Keywords: *Cissus quadrangularis Linn.*, Phytochemical, Asthishrinkhala, Pharmacological, Marketed formulations

Introduction
The current review study was created with India's long history of using medicinal plants in mind. The study has a prime focus on introducing one of the important plants of Ayurveda, named *Cissus quadrangularis*. The review article on Asthishrinkhala aims to provide a comprehensive analysis of its phytochemistry, pharmacology, clinical trials, and toxicology. Hadjod, *or Cissus quadrangularis*, is a perennial plant that belongs to the Vitaceae family. Adamant creeper, square-stemmed vine, veldt grape, devil's backbone, pirandai, Sannalam, Nalleru, Vajravelli, and Mangara Valli are some of its other names. It is indigenous to Bangladesh, Sri Lanka, and India. Africa and Southeast Asia are also home to it. Both the southern United States and Brazil are importing it. With branches with quadrangular sections and internodes that are roughly 8 to 10 cm long and 1.2 to 1.5 cm wide, *Cissus quadrangularis* can grow up to 1.5 m in height. A leathery edge runs along each angle. At the nodes, toothed trilobed leaves that are 2 to 5 cm wide emerge. Each has a tendril that emerges from the node's opposite side. (Fig.10) When ripe, globular berries turn red, and racemes of tiny white, yellowish, or greenish flowers are produced. Simple or lobed, cordate, dentate, serrate, broadly ovate or reniform, occasionally 3-foliate, and glabrous are the leaf types. On the other side of the leaves are tiny, tetramerous, bisexual, chartreuse flowers in umbellate cymes. The calyx is shaped like a cup. The fruit is an oblong or globose, fleshy berry with one seed that is succulent, highly acrid, and red to dark purple to black. (Fig.2) The seeds are either pyriform or ellipsoid. Spring and early summer are when flowers bloom [1].

Fig 1: *Cissus Quadrangularis*

Fig 2: *Cissus Quadrangularis* Flower

Taxonomy of *Cissus quandrangularis*[1]

- **Kingdom:** Plantae
- **Subkingdom:** Tracheobionta
- **Super division:** spermatophyta
- **Division:** Magnoliophyta
- **Class:** Magnoliopsida
- **Subclass:** Rosidae
- **Order:** Vitales
- **Family:** Vitaceae
- **Genus:** Cissus
- **Species:** quadrangularis

Vernacular Names [1, 2]

- **English:** Edible stemmed vine, Adamant creeper, Bonesetter
- **Hindi:** Hadjod, Hadjora, Hadsarihari, Harsankari, Kandvel
- **Bengali:** Har, Harbhanga, Hasjora, Horjora
- **Gujarati:** Chodhari, Hadsand, Hadsankal, Vedhari
- **Kanada:** Mangarahalli
- **Malyalam:** Cannalamparanta, Peranta
- **Marathi:** Horjora, Harsankar, Kandavel, Nallar
- **Tamil:** Piranti, Vajjravalli
- **Telugu:** Nalleru, Nelleratiga, Vajravalli
- **Oriya:** Hadavhanga
- **Urdu:** Harjora, Hadsankal
- **Sanskrit:** Vajravalli

The asthishrinkhala plant, also known as *Cissus quadrangularis*, has been widely used in traditional medicine for its numerous health benefits. It contains various chemical components that contribute to its medicinal properties and therapeutic value. The phytochemistry of Asthishrinkhala involves the study of its chemical components and constituents. These chemical components have been identified and analyzed through various methods such as chemical tests, chromatography, spectroscopy, NMR, Mass Spectroscopy, and NMR techniques. Some of the key chemical components found in Asthishrinkhala include ascorbic acid, beta-carotene, carbohydrates, saponins, flavonoids, triterpenoids, alkaloids, phenols, and steroids [3].

The pharmacological activities of Asthishrinkhala have been extensively studied and documented. Studies have shown that Asthishrinkhala exhibits a wide range of pharmacological activities, including antioxidant, anti-inflammatory, anticancer, antidiabetic, antimicrobial, analgesic, and bone-healing properties etc [4, 5].

Toxicology of Asthishrinkhala. The toxicological profile of Asthishrinkhala has also been investigated. Studies have evaluated its acute and chronic toxicity, as well as its potential for adverse effects. Based on the available literature, Asthishrinkhala has shown no significant toxicity or adverse effects when used within recommended doses. However, it is essential to note that additional toxicity studies are necessary to understand its safety profile fully [6].

Distribution, Cultivation & Collection

From sea level to 2000 meters above sea level, it can be found in a wide range of lowland rainfall habitats in tropical Africa, as well as in Arabia, India, Sri Lanka, Thailand, Vietnam, Indonesia, and the Philippines [7]. Found alongside hedges in India's hotter regions, as well as in Bangladesh, Sri Lanka, Pakistan, and Malaysia, among other nearby nations [8].

Stem cuttings are used to propagate it in June and July, and it needs a warm tropical climate. It is a climbing herb with simple tendrils that are opposite the leaves and eventually lose their leaves. Simple or lobed, cordate, dentate, serrate, broadly ovate or reniform, occasionally 3-foliate, and glabrous leaves are all possible. Flowers are small, greenish-white, bisexual, tetramerous, in umbellate cymes, opposite to the leaves. (Fig.3) Calyx is cup-shaped. Succulent, dark purple to black, globose or obovoid, fleshy berries with one seed; ellipsoid or pyriform seeds. Garima, dichotomously branched, subangular, glabrous, fibrous, smooth, and buff in color with a hint of green. (Fig.4) [9, 10].

Fig 3: *Cissus Quadrangularis* stem

Fig 4: *Cissus Quadrangularis* fruit

Climate: It prefers a warm tropical climate, up to an elevation of 500 m [11].

Soil: With a better water drainage system, the plant can grow in nearly any soil type. It favors loamy soil that has a pH between 5.5 and 7.5.

Propagation: Mature propagule 30 cm long and having two nodes are commercially used. Spacing and planting: Stem cuttings are planted in a pit of 15×15×15 cm at 30 × 30 cm spacing during the kharif season (June-July). The pits are loaded up with a blend containing vermicompost: FYM: sand: bone meal in equivalent extents. The plants are to be upheld with the assistance of bamboo sticks [11].

Manuring: Following planting, farm yard manure (10-12 tonnes/ha) is applied [11].

Harvesting and Yield: The crop is perennial. Eleven months after planting, the stems are cut and allowed to air dry. After two years of planting, the entire plant can be harvested [8].

Phytochemical Constituents of *Cissus quadrangularis*

Phytochemical screening is employed to examine the diverse components of plants to evaluate their biological effects or potential medicinal applications. The therapeutic efficacy of plants is attributed to specific chemical compounds with distinct physiological impacts on living organisms [12].

Cissus quadrangularis is rich in various bioactive compounds including alkaloids, resveratrol, piceatannol, pallidol, Parthenocissus, quadrangularins, ascorbic acid, carotene, phytosterols, calcium, flavonoids, vitamins, enzymes, nicotinic acid, tyrosine, and triterpenoids. Balsam ketone, amyrin, onocer-7-ene-3alpha, 21 beta-diol, taraxerol, acetyl taraxerol, and friedelin ketone are among the terpenoid chemicals found in *Cissus quadrangularis*. The primary chemical constituents are tetracyclic triterpenoids, specifically onocer-7-ene-3α, 21 β-diol, and onocer-7-ene-3-β, 21 α-diol, along with two steroidal principles known as I and II, α-sitosterol, and δ-amyrin [13, 14].

Nine compounds were separated from the stem's methanol, pet-ether, ethyl acetate, and chloroform fractions by spectroscopic and chromatographic analyses. These three constituents aliphatic acid hexadecanoic acid, the stilbene glucoside trans-resveratrol-3-O-glucoside, and the triterpene d-amyrin acetate—were first described. The remaining compounds extracted from these fractions comprise δ-amyrone, β-sitosterol, quercetin, d-amyrin, kaempferol, and resveratrol [15].

The spectral analysis of the methanolic stem extract indicates the presence of three compounds: lupeol, β-sitosterol, and friedelin. GC-MS analysis of the same extract identified a total of 19 compounds, with notable ones including n-Hexadecanoic acid, methyl linoleate, furan carboxaldehyde, 5-(hydroxymethyl), 4,8,13-Cyclotetradecatriene-1,3-diol, 1,5,9-trimethyl-12-(1-methyl ethyl), Ursolic acid, methyl ester, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol, Propane, 1,1,3-triethoxy, tocopherol, 10-Pentadecen-1-ol, methyl ester, 2-(7-heptadecynyloxy)tetrahydro-2H-Pyran, 2(1H)-naphthalenone ethyl ester, behenic acid, squalene, and hexadec-2-en-1-ol [16, 17].

The methanol extract has been shown to contain various phytochemicals, including α- and β-amyrins, β-sitosterol, ketosteroids, phenolic compounds, tannins, carotene and vitamin C and seven alicyclic lipid components have been isolated from *Cissus quadrangularis*. Further, other un-branched tetracyclic triterpenoids such as δ-amyrin, onocer-7-ene-3α, 21β-diol, and δ-amyrone have been previously reported as shown in Fig.5 [18, 19].

Fundamental subjective phytochemical evaluating for the recognizable proof of the phytoconstituents of the ethanolic concentrate of C. quadrangularis has been completed [20].

To analyze phytochemical constituents' various extracts have been used such as petroleum ether, chloroform, ethanolic extract, methanolic extract, and water extract.(Table. 1) [21]

The entire plant of Cissus quadrangularis is harvested, and different fractions from the plant extract result in many phytochemical compounds. In the parts used, these involve the roots, stems, and leaves, etc.(Table. 2) [22]

1. Aerial portion

The aerial part, especially the stem of Cissus quadrangularis, showed the existence of numerous significant primary and secondary metabolites. An extract made of various solvents was used in the study to look for the presence of preliminary phytoconstituents. It was discovered that the extract contained significant primary metabolites, including fatty acids, methyl esters, protein, amino acids, iridoids, gums, mucilage, and lipids (cyclic and acyclic). Phytochemical screening showed the presence of carbohydrates, tannins, phenolic compounds, alkaloids, phytosterols, saponins, fixed oils and fats, and flavonoids in qualitative analysis of the aerial part of the plant. This plant also contains carbohydrates, μ-sitosterol, ascorbic acid, free amino acids, gums, and mucilage. Result: The quantitative analysis of aerial parts showed a higher percentage of glycosides, terpenoids, calcium salts, L-ascorbic acids and alkaloids [9, 23, 24].

2. Roots

Phytochemical examination of *Cissus quadrangularis* roots has identified several significant chemical groups such as terpenoids, alkaloids, phenols, and flavonoids. Additionally, these roots are recognized for harboring bioactive compounds responsible for medicinal attributes, notably antioxidant and antimicrobial properties. The presence of these phytochemical constituents underscores the potential health advantages linked with *Cissus quadrangularis* roots [5, 25].

3**. Stem**

The stem of *Cissus quadrangularis* contains two asymmetrical tetracyclic triterpenoids and two steroidal principles. Additionally, β-sitosterol, δ-amyrin, δ-amyrone, and flavonoids like quercetin have been identified, each with diverse metabolic and physiological effects. Unique stilbene derivatives, referred to as quadrangularins A, B, and C10, have also been discovered in the stem.

Phytochemical investigations on this extract unveiled the presence of triterpenes such as α- and β-amyrins, β-sitosterol, ketosteroids, phenols, saponins, tannins, carotene, and vitamin C. Quantitative analysis demonstrated the composition of *Cissus quadrangularis* plant, showing moisture at 12.1%, protein at 10.4%, fat and wax at 1.0%, fiber at 13.4%, carbohydrates at 37.2%, mucilage and pectins at 1.1%, and ash at 16.7% [14, 26].

55 compounds, primarily 14 benzenoids, 9 steroids, 11 triterpenes, 5 tocopherols, 4 flavonoids, 2 tannins, 2 benzoquinones, 5 chlorophylls, and 3 other compounds, were extracted from fresh stems using NMR and mass spectral data analyses. 1,2-bis-(5-γ-tocopheryl) ethane was the first of these compounds to be isolated [27].

4. Leaves

The leaf extracts in methanol and ethanol indicate the presence of alkaloids, flavonoids, tannins, terpenoids, saponins, proteins, carbohydrates, and phenols.[6]

Analysis of the ethanolic extract from leaves using GC-MS has led to the identification of n-hexadecanoic acid, phytol, bis(2-methyl propyl) ester, ethyl ester, phthalic acid, caffeine, palmitic acid, 3-dodecanol, 3,3,11-trimethyl, dibutyl phthalate, and pentane, 1,1-diethoxy compounds [28, 29].

Table 1: Phytochemicals in Different Extracts

Phytochemical constituents	Petroleum ether	Chloroform	Ethanolic extract	Water extract	Methanol extract
Alkaloids	+	+	+	-	-
Flavonoids	+	+	+	+	+
Flavones	+	+	-	+	+
Chalcones	-	-	+	-	-
Terpenoids	+	+	+	+	+
Phytosterol	+	-	+	-	+
Phenol	-	-	+	-	-
Tannins	-	-	+	-	+
Saponin	-	-	+	+	+
Glycosides	+	+	+	+	-
Cardiac glycosides	+	+	+	+	-
Anthraquinone glycosides	-	-	-	-	-
Protein	-	+	+	-	-

Table 2: Phytochemicals Isolated from CQ

Sl.no	Phytochemicals	Parts of herb
1	Flavonoid and flavonoid glycosides Kaempferol Quercetin Daidzein quercitrin	Stem Whole herb Leaves Whole herb
2	Alkaloids Quinine Caffeine	Leaves Whole herb
3	Terpenes and Terpenoids Taraxerol acetate δ-Amyrone Friedelan-3-one Eugenol	Stem Stem Aerial parts Stem
4	Iridoids[30] 6-O-[2,3dimethoxy]-trans cinnamoyl catalpol 6-O-meta-methoxy-benzoylcataphol	Whole herb Whole herb
5	Stilbene derivatives and Stilbenoid Glycoside[31] Piceatannol Resveratrol Quadrangularin A Quadrangularin B	Leaves Leaves Whole herb Whole herb
6	Lipid constituents and Fatty acids Hexadecanoic acid Tetratriactanoic acid Heptadecyl-octadecanoate	Stem Leaves Aerial parts
7	Indane derivatives Pallidol	Leaves
8	Alcoholic compounds Tetratriacotanol	Leaves
9	Vitamins Vitamin C	Stem
10	Steroids β-sitosterol	Stem
12	Glycosides Cardiac glycosides	Stem

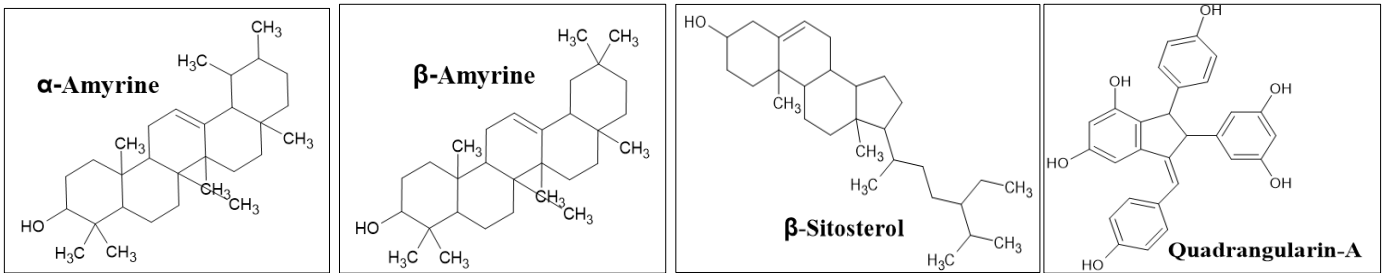

Fig 5: Structures of the Phytochemical Constituents

Pharmacological use

1. **Bone fracture healing activity**

Cissus quadrangularis, identified as a "Bone Setter," accelerates fracture healing through its rich content of phytogenic steroids and vitamins. Studies show its systemic action in stimulating metabolism and enhancing mineral uptake by osteoblasts, leading to expedited early ossification and callus formation. Animal experiments demonstrate its ability to hasten fibroblastic, collagen, and osteochondroital phases, shortening fracture healing time significantly.[16] Moreover, *Cissus quadrangularis* mitigates cortisone-induced delays in healing, promoting mineralization and tensile strength while neutralizing anti-anabolic effects. Clinical trials affirm its efficacy, reducing healing time by up to 53% and relieving fracture-related symptoms. Pharmacologically, it initiates osteogenesis, enhances alkaline phosphatase activity, and accelerates mineralization, ensuring faster, higher-quality bone healing [31-49].

2. Gastro-protective Activity

Cissus quadrangularis, valued in traditional medicine for gastric ailments, exhibits potent gastroprotective effects against aspirin-induced mucosal damage. Its extract (CQE) mitigates inflammation, oxidative stress, and DNA damage while enhancing antioxidant defenses. Administered as pretreatment, CQE significantly protects against ulcer formation, outperforming standard drugs like ranitidine. Triterpenoids and β-sitosterols contribute to its efficacy by countering lipid peroxidation and promoting mucosal integrity. Overall, *Cissus quadrangularis* demonstrates promising pharmacological actions in alleviating gastric toxicity and preserving gastric health [50-56].

3. Antioxidant activity

Cissus quadrangularis extracts demonstrate potent antioxidant activity, scavenging free radicals and inhibiting lipid peroxidation. Studies show the reversal of liver damage induced by carbon tetrachloride through restoration of antioxidant enzyme activities. The plant's stem, rich in vitamin C, carotenoids, and steroidal compounds, contributes to its antioxidant effects. Overall, *Cissus quadrangularis* shows promising pharmacological actions as an antioxidant, beneficial for combating oxidative stress-related conditions [19, 57-66].

4. Anabolic and Androgenic activity

Cissus quadrangularis accelerates bone remodeling and enhances bone tensile strength, leading to significantly faster fracture healing times compared to controls in clinical trials. It exhibits anti-glucocorticoid properties, counteracting the weakening effects of cortisol on bones and skeletal muscle tissue. Glucocorticoids induce muscle breakdown through the Ubiquitin-Proteasome pathway, but Cissus's anabolic and anti-glucocorticoid effects help preserve muscle tissue during physical and emotional stress. Overall, *Cissus quadrangularis* demonstrates promising pharmacological actions in promoting bone health and muscle preservation, particularly relevant for athletes and bodybuilders [67-69].

5. Analgesic activity

Cissus quadrangularis demonstrates significant analgesic activity, lasting 2-4 hours, even at small doses. Its effectiveness rivals that of acetylsalicylic acid (Aspirin), making it a promising option for pain relief, particularly in bone fractures. Further research is needed to uncover its active constituents and mechanism of action [5, 45, 70].

6. Anti-inflammatory activity

Cissus quadrangularis shows potent anti-inflammatory activity by inhibiting edema formation induced by arachidonic acid. Its components, including flavonoids and β-sitosterol, block both lipoxygenase and cyclooxygenase pathways, suggesting dual inhibition of arachidonic acid metabolism. This makes it comparable to aspirin or ibuprofen in its anti-inflammatory effects. Additionally, Cissus extract inhibits COX-1 activity, further confirming its anti-inflammatory properties. Its inclusion in Ayurvedic formulations underscores its effectiveness in healing fractures and associated disorders [71-76].

7. Antihemorrhoidal Activity

Cissus quadrangularis demonstrates significant antihemorrhoidal activity, attributed to its flavonoid content, particularly diosmin and hesperidin. These bioflavonoids exhibit anti-inflammatory, analgesic, and venotonic effects, which are essential for treating hemorrhoids and varicose veins. The flavonoids, along with β-sitosterol, contribute to the anti-inflammatory effect observed in Cissus quadrangularis. Moreover, the venotonic effect of the plant is comparable to that of diosmin and hesperidin, making it a potential alternative for treating hemorrhoids. Its analgesic effect further enhances its therapeutic value in relieving pain associated with hemorrhoids. Overall, *Cissus quadrangularis* validates its traditional use as an antihemorrhoidal agent, offering a comprehensive approach to managing hemorrhoidal symptoms.

To completely comprehend the mechanisms underlying these effects and to establish the right dosages for therapeutic use, more research is necessary.

Toxicological Studies: A review was done on toxicity to assess the subchronic effects of *Cissus quadrangularis* powder on Wistar rats over three months. Five groups, each consisting of 12 rats of both sexes, were utilized. The control group received a daily oral dose of 10 ml of water per kg of body weight. The treatment groups were administered dried stem powder orally at doses of 0.03, 0.3, 3.0, and 30 g/kg BW/day, which corresponded to 1, 10, 100, and 1000 times the therapeutic dose in humans, respectively. Additionally, there was a recovery group. No significant differences in initial or final body weights were observed between the rats treated with *Cissus quadrangularis* and the control group.[38,69] The study revealed that *Cissus quadrangularis* did not induce any notable dose-dependent alterations in hematological parameters or serum clinical chemistry. Furthermore, no histopathological lesions indicative of toxicity from *Cissus quadrangularis* were observed in any internal organs. These findings suggest that the doses of *Cissus quadrangularis* administered did not induce toxicity in the rats during the three-month experimental period [77, 78].

Marketed Formulation: Marketed *Cissus quadrangularis* formulations, available in tablets, capsules, powders, and liquids, offer convenient ways to tap into its health benefits. Developed by various companies, these formulations cater to diverse consumer preferences and wellness goals. The table below provides a quick summary of these products, outlining brand names, doses, and prices for easy comparison and selection. (Table. 3)

Table 3: Marketed Products

Sl.no.	Type	Brand Name	Company Name	Dose	Price
1.	Tablet	Cissus 600	Himalaya Wellness	600 mg	₹320 (60 tablets)
2.	Capsule	Cissus Elite	Organic India	900 mg	₹420(60 capsules)
3.	Tablet	Cissus Power	NutraHerbals	700 mg	₹380 (60 tablets)
4.	Capsule	Cissus Prime	Himalaya Herbal Healthcare	850 mg	₹450(60 capsules)
5.	Powder	Cissus Flex	Vedan Nutrition	600 mg	₹480 (100 grams)
6.	Liquid	Cissus Liquid Plus	Ayurvedic Herbs	1000 mg/ml	₹700 (30 ml)
7.	Tablet	Cissus Vitality	Organic India	800 mg	₹400 (60 tablets)
8.	Capsule	Cissus Strength	Ayurvedic Wellness	1200 mg	₹500 (60 capsules)
9.	Tablet	Cissus Forte	Organic Wellness	700 mg	₹350 (60 tablets)
10.	Capsule	Cissus Supreme	Ayurvedic Naturals	950 mg	₹480 (60 capsules)
11.	Powder	Cissus Boost	Vedan Nutrition	800 mg	₹550 (100grams)
12.	Liquid	Cissus Elixir	Ayurvedic Remedies	1500 mg/ml	₹800 (30 ml)
13.	Tablet	Cissus Ultimate	Ayurvedic Naturals	1000 mg	₹450 (60 tablets)
14.	Capsule	Cissus Wellness	Ayurvedic Wellness	1300 mg	₹600 (60 capsules)
15.	Tablet	Cissus Gold	Ayurvedic Remedies	850 mg	₹420 (60 tablets)

1. Chutney: It is a spicy side dish in Indian subcontinental cuisine. V. Hemalatha, a housewife from Pallipalem in the East Godavari District of Andhra Pradesh, made the revelation. The following ingredients are included: groundnuts, Bengal gram dal, red chilies, garlic, cumin seeds, coriander seeds, curry leaves, mustard seeds, tamarind juice, oil or ghee, and stem pieces of C. quadrangularis L. It is yummy and typically served with rice, curd rice, and idly.It particularly suits women during puberty and those in whom bone pain and fracture occur [79]. (Fig.6).

Fig 6: *Cissus quadrangularis* chutney

Fig 7: *Cissus quadrangularis* vada

2. Vada: Black gram fried snack is mainly prepared from this legume. This fact was revealed by K. Anasuya, a housewife from Kakinada in the East Godavari District of Andhra Pradesh. This fried snack preparation is specifically suggested for growing kids, people suffering from bone pain, and those with fractures [79]. (Fig.7)

3. Dosa: A fermented crepe, typically made with black gram and rice batter. In the southern Indian states of India, it is a staple food. V. Ramalakshmi, a housewife from Pallipalem in the East Godavari District of Andhra Pradesh, disclosed Ingredients: rice, oil or ghee, cumin seeds, salt, tamarind juice, and stem pieces of C. quadrangularis L. It is particularly recommended for growing children, people with bone pain, and those who have fractures. (Fig 8) [79, 80].

Fig 8: *Cissus quadrangularis* dosa

Fig 9: *Cissus quadrangularis* pickle

The *Cissus quadrangularis* stem is fried in ghee and administered with milk for the treatment of wound healing, fractures, and osteoarthritis.

The stems of the plant are eaten as a pickle to strengthen the bones and to regain the damage of epithelial cells in case of any injury. (Fig.9) [1]

Conclusion

Based on the available research on asthishrinkhala (Cissus quadrangularis), it can be concluded that this plant has a rich phytochemical profile, containing various bioactive compounds such as flavonoids, triterpenoids, and phytosterols. These compounds contribute to its pharmacological actions, which include anti-inflammatory, analgesic, antioxidant, and bone-strengthening properties. Clinical trials on asthishrinkhala have shown promising results in the management of conditions such as osteoporosis, arthritis, and bone fractures.

Hence, forthcoming research should concentrate on formulating innovative preparations and delivery mechanisms for Asthi Shrinkhala to enhance its therapeutic efficacy. Overall, asthishrinkhala shows great potential as a natural

remedy for bone health and inflammatory conditions, but more research is warranted to fully understand its mechanisms of action optimize its medicinal use, and confirm its safety and efficacy.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Studies involving plants

This article is a review and does not involve original studies on plants. Not applicable.

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