FORMULATION AND EVALUATION OF A HADJOD SUPPLEMENTARY POLYHERBAL POWDER INTENDED FOR FRACTURE HEALING

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Abstract

Cissus quadrangularis Linn. is an indigenous medicinal plant, grown in India, which helps to increase healing process of fractured bone. Fracture of maxillofacial skeletal takes reasonably long time to heal. Many attempts have been made till today to reduce the healing period of 6–8 weeks, by means of improved surgical technology or by inhibiting the physiological mechanism of bone healing. The whole plant including all parts such as stems, leaves, roots is documented to possess medicinal properties in ethnobotanical surveys conducted by ethnobotanists in the traditional system of medicine. Cissus quadrangularis contains ; Triterpenes i.e. - α- and β- amyrine, β- sitosterol etc , Unsymmetric tetracyclic such as triterpenoids- damyrin, 3,3',4,4'-tetra hydroxy biphenyl etc. and Flavonoids such as quercetin, kaempferol, quadrangularins A,B,C etc. Stem extract has high percentage of calcium ions and phosphorus, both of which is essential for bone growth. In Ayurveda this plant has been documented for the treatment of osteoarthritis, rheumatoid arthritis, and osteoporosis.

Keywords: Cissus quadrangularis, Bone Healing, Osteoporosis

INTRODUCTION

Ayurveda, the ancient science of medicine describes different types of herbal preparations that achieve the hastening of bone healing.In Ayurveda, most of the names of the plants have been given according to their medicinal values. The plant is known as Harishankar or Hadjod in Hindi and Asthisanghata, Kandavalli, Vajrangi, etc., in Sanskrit. Hadjod means that which joins the bones [1, 2]

Bone fractures represent one of the most common traumatic injuries encountered worldwide. The global burden of fractures is escalating due to factors such as increasing incidences of osteoporosis, road traffic accidents, sedentary lifestyles, nutritional deficiencies, and the ageing population. While clinical management of a fracture relies primarily on immobilisation, surgical fixation, and pharmacological pain control, the actual repair of the bone tissue itself depends heavily on the nutritional and biochemical milieu of the patient during the healing window.

From a physiological standpoint, bone is a dynamic, mineralised connective tissue composed primarily of a collagen-rich organic matrix impregnated with hydroxyapatite crystals. The mineral fraction supplies compressive strength, while the organic component lends tensile toughness. Any disruption to the

continuity of this composite — whether traumatic or pathological — initiates a tightly regulated biological response involving osteoblasts, osteoclasts, chondrocytes, and a wide range of inflammatory mediators. The efficiency of this response is strongly dependent on the systemic availability of calcium, phosphorus, zinc, magnesium, vitamin D, vitamin K2, protein, and several phytoconstituents that modulate inflammation and oxidative stress.

Healing of bone tissue is a complex biological process involving an orchestrated sequence of inflammation, soft callus formation, hard callus development, and bone remodelling. The inflammatory phase lasts for the first 3–7 days and is characterised by haematoma formation and infiltration of immune cells. This is followed by the reparative phase, during which fibroblasts and chondrocytes lay down a soft callus that is gradually mineralised. Finally, the remodelling phase — which may extend over several months — replaces the woven bone of the callus with mature lamellar bone, restoring the original mechanical properties of the limb. Any compromise in nutrition, blood supply, or mechanical stability during these phases can result in delayed union or non-union, leading to chronic disability and prolonged medical expenses. With approximately 178 million new fractures reported globally each year, the development of safe, affordable, and well-tolerated supportive interventions — taken alongside standard clinical care — has become an important priority for modern healthcare [3-5].

Traditional Indian medicine systems, particularly Ayurveda, have long recognised the value of herbs in supporting bone health. Classical Ayurvedic texts such as Charaka Samhita and Bhavaprakasha Nighantu describe formulations employing bone-supportive herbs collectively termed Asthi Sandhaniya Dravyas — substances that promote the union of bones. These classical preparations were originally prescribed during convalescence, typically as decoctions or fine powders consumed with milk, ghee, or honey, and were intended to provide both mineral nourishment and pharmacological support to the recovering patient. In the modern context, these classical preparations are best positioned not as stand-alone therapy but as supplementary nutraceutical support to be used alongside conventional fracture management.

The global nutraceutical market has expanded rapidly over the past two decades, with bone-health and joint-health supplements forming one of the fastest-growing categories. Consumers are increasingly drawn to plant-derived preparations that offer demonstrated mechanistic benefits with comparatively low toxicity, and regulatory bodies such as the Food Safety and Standards Authority of India (FSSAI) have begun to recognise polyherbal nutraceuticals as a distinct product class that is both reproducible at laboratory scale and well-positioned for future scale-up. The end product is positioned as a supplementary nutraceutical intended to support fracture healing, not as a substitute for clinical care, and the experimental design reflects this scope throughout [7].

The Need for Comprehensive Nutritional Support

When a bone fractures, the body's metabolic demand increases significantly to support the tissue repair process. While conventional treatments focus on putting the bone back in place and managing pain, the body still requires building blocks to create new bone. Standard clinical care often includes basic calcium and vitamin D supplements. However, bone healing is not just about calcium; it also requires managing inflammation, improving local blood circulation, and stimulating the cells that build the bone matrix [10].

Many patients experience gastrointestinal discomfort, such as constipation or bloating, from high doses of synthetic calcium supplements. This creates a need for alternative or supplementary options that are gentler on the stomach, derived from natural sources, and capable of supporting the entire healing process — from reducing initial swelling to strengthening the final bone tissue.

For the purpose of fracture healing, a polyherbal formulation is highly beneficial for several distinct reasons:

Multiple Benefits at Once: One herb in the mixture might be naturally rich in easily absorbable minerals (like plant-based calcium and silica). A second herb might act as a natural anti-inflammatory to reduce pain and swelling around the fracture. A third herb might help speed up the actual growth of new bone cells [11-13].

Lower Doses, Fewer Side Effects: Because the herbs work together, smaller amounts of each plant can be used. This reduces the risk of any unwanted side effects that might happen if a patient took a massive dose of just one single plant.

Holistic Healing: This approach aligns with the natural healing sequence of the body, providing gentle, continuous support throughout the weeks or months it takes for a bone to fully mend.

Advantages of a Powder Dosage Form

Once the herbs are selected, choosing how to deliver them to the patient is a crucial step. For this study, a powdered dosage form was chosen over modern tablets or capsules for several practical reasons [14].

PLANT PROFILES

Each of the five botanical (and one zoological) ingredients used in the present supplementary polyherbal powder has been profiled below with respect to botanical identity, family, part used, active constituents, traditional therapeutic uses, and proposed mechanism of action in bone healing support. Plant photographs are provided for visual identification, and the accompanying tabular summary follows the format recommended for monographs in the Indian Herbal Pharmacopoeia and in WHO guidelines for the standardisation of medicinal plants.

Figure 1: Cissus quadrangularis (Hadjod / Veldt Grape)

Botanical Name	*Cissus quadrangularis*
Common Name	Hadjod / Veldt Grape
Family	Vitaceae
Part Used	Stem

Active Constituents	Phytosterols (β-sitosterol), quercetin, kaempferol, ketosteroids, calcium, carotenoids
Therapeutic Uses	Bone fracture healing support, osteoporosis, analgesic, anti-inflammatory, antioxidant

MATERIALS AND METHODS

All five herbal ingredients — Cissus quadrangularis (stem), Withania somnifera (root), Terminalia arjuna (bark), Commiphora mukul (oleo-gum resin), and Laccifer lacca (resinous secretion) — were procured from a certified supplier of Ayurvedic raw materials and authenticated by a qualified botanist. Each consignment was accompanied by a Certificate of Analysis indicating geographical origin, batch number, and date of collection, in line with the documentation practices recommended for nutraceutical raw materials [15-18].

Table 1: Composition of the Supplementary Polyherbal Powder (F1, F2, F3)

Ingredient	F1 (g)	F2 (g)	F3 (g)	Role
Cissus quadrangularis	3.0	4.0	2.5	**Osteogenic**
Withania somnifera	2.0	2.5	3.0	**Adaptogen**
Terminalia arjuna	2.0	1.5	2.0	**Antioxidant**
Commiphora mukul	1.5	1.0	1.5	**Bio-enhancer**
Laccifer lacca	1.5	1.0	1.0	**Mineral source**
Total	**10.0**	**10.0**	**10.0**	**—**

The compositional ratios in Table 1 were chosen on the basis of the literature reviewed in F1 represents a balanced blend with moderate Cissus content; F2 increases the proportion of the principal osteogenic herb at the expense of the minor ingredients; F3 shifts the balance toward the adaptogenic herb. This design allows a direct comparison of how compositional weighting affects both the flow behaviour of the powder and its organoleptic profile [19].

Preparation of the Formulation

Each herb was dried under shade for 7–10 days to preserve heat-sensitive constituents, then powdered individually using a mechanical pulveriser and sieved through mesh #60 to obtain a uniform fine powder suitable for oral supplementation. Shade-drying was selected in preference to oven-drying or sun-drying because volatile and thermolabile constituents — particularly the guggulsterones of Commiphora mukul and the withanolides of Withania somnifera — are susceptible to thermal degradation at temperatures above 50°C. The relative humidity of the drying area was monitored daily, and drying was continued until each material achieved a constant weight [21-23].

The individual powders were weighed accurately on an analytical balance (sensitivity ±0.1 mg) and blended geometrically in the proportions listed in Table 1 to prepare three supplementary formulations (F1, F2, F3). Geometric dilution was used to ensure uniform distribution of the minor components (Commiphora mukul and Laccifer lacca) within the larger bulk of Cissus quadrangularis and Withania somnifera. Each blend was passed through mesh #60 a second time to ensure homogeneity, then stored in airtight, amber-coloured containers at room temperature, away from direct sunlight, until further evaluation. The use of amber containers minimises the risk of light-induced degradation of phytoconstituents, while the air-tight closure protects the powders from moisture pick-up that would otherwise affect both flow properties and microbial stability.

RESULT AND DISCUSSION

1. Organoleptic Evaluation

All three supplementary formulations (F1, F2, F3) were subjected to organoleptic evaluation. The results are presented in Table 2 below. All formulations were found to be acceptable in terms of colour, odour, taste, and texture, with characteristic herbal notes attributable to the polyherbal nature of the blend. These properties are particularly important for an oral supplement, since palatability and appearance directly influence long-term patient compliance.

Table 2: Organoleptic Evaluation of the Supplementary Polyherbal Powder

Parameter	F1	F2	F3	Inference
Colour	Light brown	Brown	Dark brown	**Acceptable**
Odour	Characteristic herbal	Characteristic herbal	Characteristic herbal	**Acceptable**
Taste	Slightly bitter	Bitter	Bitter	**Acceptable**
Texture	**Fine powder**	**Fine powder**	**Fine powder**	**Acceptable**

The progressive deepening of colour from F1 (light brown) through F2 (brown) to F3 (dark brown) reflects the increasing proportion of darker components — particularly Withania somnifera root and Laccifer lacca — in the higher-numbered formulations. The taste profile became more pronouncedly bitter with the higher proportion of Withania, consistent with the characteristic bitterness of withanolide-rich preparations. None of the three formulations exceeded the boundary of acceptable palatability, but F1 was rated as the most palatable on first taste, with F2 close behind [24].

Figure 2: Supplementary Polyherbal Powder – Final Product (Formulation F2)

2. Physicochemical Evaluation

Table 3: Bulk Density, Tapped Density, Carr's Index and Hausner's Ratio

Formulation	Bulk Density (g/mL)	Tapped Density (g/mL)	Carr's Index (%)	Hausner's Ratio
F1	0.412	0.476	8.40	**1.155**
F2	0.438	0.498	12.05	**1.137**
F3	0.395	0.461	14.32	**1.167**
USP Limit	—	—	**NMT 25%**	**NMT 1.25**

The angle of repose and loss-on-drying results are summarised in Table 4 below.

Table 4: Angle of Repose and Loss on Drying of Formulations

Formulation	Angle of Repose (°)	LOD (% w/w)	Flow Property
F1	28.4	3.2	**Good**
F2	26.7	3.6	**Excellent**
F3	**31.2**	**4.1**	**Passable**

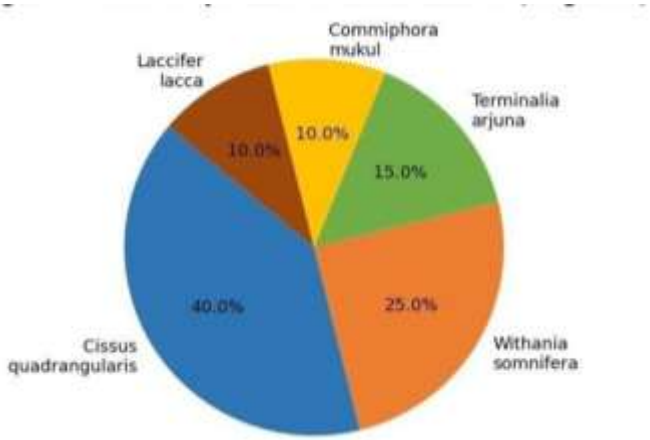

Figure 3: Herb Composition of Formulation F2 (10 g total)

CONCLUSION

The present study successfully formulated and evaluated a novel supplementary polyherbal powder intended for fracture healing, comprising five Ayurvedic ingredients of well-documented relevance to bone health — Cissus quadrangularis, Withania somnifera, Terminalia arjuna, Commiphora mukul, and Laccifer lacca — prepared in three trial formulations (F1, F2, and F3) with systematically varied compositional ratios. The work was carried out with the explicit aim of translating a classical Ayurvedic concept into a reproducible, pharmacopoeially compliant nutraceutical powder.

All three formulations passed organoleptic evaluation, exhibiting acceptable colour, odour, taste, and texture consistent with the expectations for a herbal supplementary powder dosage form. On comparative physicochemical assessment, Formulation F2 emerged as the optimal candidate, demonstrating the best balance of compressibility and flowability — a Carr's Index of 12.05%, a Hausner's Ratio of 1.137, an angle of repose of 26.7°, and a loss-on-drying value of 3.6%. All of these values comfortably meet the corresponding USP specification limits.

The synergistic combination of osteogenic, anti-inflammatory, adaptogenic, antioxidant, and bioavailability-enhancing constituents in the present formulation represents a promising Ayurvedic supplementary approach for supporting bone fracture healing, with a low likelihood of side effects relative to long-term conventional pharmacotherapy. The formulation thus serves as a meaningful example of how classical pharmacological principles can be translated into a modern, standardised herbal supplement that can be evaluated using internationally recognised pharmacopoeial methods.

From a public-health perspective, the development of safe, cost-effective, and culturally acceptable supplementary preparations to support bone-healing is increasingly important in a country such as India, where fractures from road traffic accidents, occupational hazards, and age-related osteoporotic conditions impose a substantial burden on the healthcare system. A standardised supplementary polyherbal powder,

supported by reproducible flow data and pharmacopoeial compliance, holds promise as a potential adjunct to conventional fracture management — not as a substitute for it, but as a nutraceutical companion that may help optimise the patient's recovery environment [25].

It must, however, be acknowledged that the present study is limited to in-vitro physicochemical characterisation and does not yet include direct biological evaluation. The findings are therefore best interpreted as a foundation upon which subsequent biological, pharmacokinetic, and clinical studies can be built.

Future research should proceed along the following directions to strengthen and extend the present findings:

- In-vivo evaluation of fracture healing support in established rodent models, with histopathological and radiographic confirmation of accelerated callus formation when the supplement is administered alongside standard fracture care.

- Phytochemical fingerprinting of the optimised formulation (F2) using HPTLC, HPLC, or GC-MS to ensure batch-to-batch consistency of the chemical profile.

- Accelerated and long-term stability studies under ICH Q1A(R2) guidelines to determine shelf life and appropriate packaging recommendations for the supplement.

- Acute and sub-chronic toxicity studies in accordance with OECD guidelines to establish a comprehensive safety profile suitable for nutraceutical positioning.

- Pharmacokinetic profiling of the principal active constituents from Formulation F2, particularly to confirm enhanced bioavailability attributable to the Guggulu component.

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