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Review Article

"A NUTRACEUTICAL PERSPECTIVE OF ELEPHANT FOOT YAM PROMOTING BONE REGENERATION"

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ABSTRACT

The universal role of plants in disease treatment is well established through their use in herbal medicine. Understanding medicinal plants requires knowledge from multiple disciplines, including botany, horticulture, chemistry, pharmacology, genetics, enzymology, and quality control. Despite significant advances in medicine, many plant species with potential therapeutic value remain unexplored, and continuous research is being conducted to identify their pharmacological applications.

This review focuses on the bone regenerative potential of Amorphophallus paeoniifolius, commonly known as Elephant Foot Yam, Suran, Kanda, or Jimikand. Periodontitis is a chronic inflammatory disease of the oral cavity that causes progressive destruction of periodontal tissues, including the periodontal ligament and alveolar bone, ultimately leading to tooth loss. Regenerative therapies such as guided tissue regeneration (GTR), bone grafting, and biomaterial-based approaches are commonly used to restore damaged tissues and promote new bone formation.

Bone regeneration is a complex biological process involving osteoblasts, osteoclasts, extracellular matrix formation, and growth factors that coordinate tissue repair. Recent interest in plant-based therapeutics has encouraged the investigation of natural agents capable of supporting bone healing by reducing inflammation, controlling oxidative stress, and stimulating osteoblastic activity.

Among these natural agents, Amorphophallus paeoniifolius has attracted attention because of its antioxidant-rich composition and possible bioactive compounds that may aid cellular repair and bone regeneration. Preliminary findings suggest its potential supportive role in periodontal therapy; however, further in vitro, in vivo, and clinical studies are necessary to confirm its efficacy, safety, and exact mechanism of action in periodontal bone regeneration.

Key word: Dioscorea yams, Amorphophallus Paeoniifolius, Periodontitis, Bone regeneration, Jimikand, Suran, Guided tissue regeneration.

INTRODUCTION

Herbal medicine is the use of parts of plants—such as roots, stems, leaves, or flowers—to treat illness, maintain health, and improve well-being, often using the whole plant rather than isolated ingredients. These plant-based products, also known as botanicals or phytomedicines, are available in forms like teas, extracts, powders, capsules, and oils, but they are not subject to the same rigorous testing as conventional drugs and can interact with other medications **[1]**.

Amorphophallus paeoniifolius is a tropical tuberous plant belonging to the Araceae family. It is commonly known as Elephant Foot Yam, and is widely called Suran, Jimikand, or Kanda in different parts of India [2,8]. Botanical Information; Family: Araceae, Genus: Amorphophallus, Species: *A. paeoniifolius*, Plant type: Perennial tuber crop.

Produces a large underground tuber (corm). Leaves are large, umbrella-shaped and deeply divided; the flower is a single spadix with a spathe structure typical of the Araceae family; it has a strong odor during flowering [5].

[Effect of Yam on Periodontosis] *Amorphophallus paeoniifolius* has been studied in the context of periodontal diseases due to its nutritional and bioactive properties, which may support oral tissue health and healing in conditions like periodontosis (periodontitis) [4, 5].

Anti-inflammatory Effect: Periodontosis is mainly a chronic inflammatory disease. Yam contains bioactive compounds such as polyphenols and flavonoids [4, 8]. These may help in reducing gingival inflammation and decreasing tissue swelling and bleeding. Antioxidant Action: Oxidative stress contributes to periodontal tissue destruction. Yam has antioxidant properties that neutralize free radicals, protect periodontal ligament cells, and slow down tissue degeneration [2, 3].

Botanical & Nutritional Profile

Amorphophallus paeoniifolius (Elephant Foot Yam) behaves as a traditional "functional food" or "medicinal food" due to its rich composition of both macro and micronutrients [4, 5]. Key Bioactive Phytochemicals the corm contains key metabolites crucial for cellular pathways, including resveratrol, quercetin, rutin, gallic acid, betulinic acid, and lupeol. It also houses specific diterpenoids, triterpenoids, and phytosterols like β-sitosterol [2, 3, 8].

Nutritional Carriers: It is heavily loaded with the mineral zinc, calcium, phosphorus, and vitamins (thiamine, riboflavin, niacin, carotene) which are primary structural and metabolic building blocks for bone matrix mineralization **[4, 8]**.

Bone Regeneration & Anti-Periodontitis: To validate the yam from a nutraceutical perspective, its chemical constituents can be mapped directly onto the biological phases of bone repair and periodontal healing:

Modulating Inflammation (The Anti-inflammatory Phase): Periodontitis is driven by chronic, destructive inflammation. Phytochemicals in Elephant Foot Yam—such as **quercetin and gallic acid**—are well-known down-regulators of pro-inflammatory cytokines (like TNF-α, IL-1β, and IL-6). By suppressing these signals, the yam prevents the over-activation of **osteoclasts** (bone-resorbing cells) which otherwise cause alveolar bone loss. [12,13,14]

Promoting Osteoblastic Activity (The Bone-Forming Phase):

Lupeol and Betulinic Acid, these triterpenoids have been shown in modern pharmacological screenings to stimulate **osteoblast** differentiation and increase the expression of Alkaline Phosphatase (ALP)—a key enzyme required for bone mineralization. [11,14]

Phytoestrogens the plant contains sterols (β-sitosterol) that can weakly bind to estrogen receptors. In bone biology, estrogenic pathways stimulate osteoblasts to produce osteoprotegerin (OPG), a decoy receptor that blocks bone resorption, yielding an anti-osteoporotic effect (Ansil). [11,14]

Mitigating Oxidative Stress: Chronic oral infections produce massive amounts of Reactive Oxygen Species (ROS) that destroy the periodontal ligament. The antioxidant-rich matrix of *A. paeoniifolius* neutralizes free radicals, safeguarding surrounding healthy mesenchymal stem cells (MSCs) so they can successfully differentiate into new bone tissue. [12,13]

Antimicrobial Defense in the Oral Cavity: In the context of periodontitis and endodontic-periodontal lesions, controlling the bacterial bio-burden is vital before regeneration can occur. Interestingly, modern *in vitro* dental research has shown that crude extracts of *Amorphophallus paeoniifolius* (Suran) possess potent antibacterial properties against stubborn oral pathogens like *Enterococcus faecalis*, demonstrating efficacy that stands competitive against standard intracanal medicaments like calcium hydroxide. This dual action—acting as an antimicrobial while simultaneously nourishing cellular repair—makes it an ideal nutraceutical candidate.

Elephant foot yam: Elephant foot yam (Amorphophallus Paeoniifolius), (Family Araceae) is the "king of tuber crops" popularly known as "oal" or "suran" and is one of the important aroid tuber vegetable crop cultivated for its corms in tropical and subtropical regions of Africa, South Asia, Southeast Asia, and the tropical Pacific islands. It is tuber and also used as a vegetable. It is a most important source of carbohydrates after rice & maize. It is widely used in countries like India, Indonesia, Srilanka. This crop is propagated mainly through vegetative propagules (corms and tubers). In India E is Elephant foot yam is cultivated in the states of Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand in 30ha area .It is also commonly used in medicine for bronchitis, asthma, abdominal pain, emesis, dysentery, enlargement of spleen, piles, elephantiasis and rheumatic swelling.

Elephant foot yam is a major stable food crop for the tribal people of Asian countries and identification of phytoplasma disease in EFY poses a serious threat to EFY cultivation. More studies are required for distribution of phytoplasma-associated diseases in Asian countries. A single yam packs a whopping yam 369% of your daily vitamin` A' requirements. [16,17,18,19,20]

A monocot related to lilies and grasses, yams are vigorous herbaceous, perennially growing vines from a tuber. Some 870 species of yams are known, a few of which are widely grown for their edible tuber but others of which are toxic (such as D. communis). Yam plants can grow up to 15 metres (50 feet) in length and 7 to 15 centimetres (3 to 6 inches) high. The tuber may grow into the soil up to 1.5 m (5 ft) deep. The plant disperses by seed. The edible tuber has a rough skin that is difficult to peel but readily softened by cooking. The skins vary in color from dark brown to light pink. The majority, or meat, of the vegetable is composed of a much softer substance ranging in color from white or yellow to purple or pink in mature yams. [21,25,29,30]

Table No:2 Nutrition Contents in Yam

FACTOR	NUTRITIONAL VALUE / per 100gm
1) Energy	494 kJ (118 kcal)
2) Carbohydrates	27.9 g
3) Sugars	0.5 g
4) Dietary fibers	4.1 g
5) Fat	0.17 g
6) Protein	1.5 g

Storage Conditions of Yam

Roots and tubers such as yam are living organisms. When stored, they continue to respire, which results in the oxidation of the starch (a polymer of glucose) contained in the cells of the tuber, which converts it into water, carbon dioxide, and heat energy. During this transformation of the starch, the dry matter of the tuber is reduced.

Amongst the major roots and tubers, properly stored yam is considered to be the least perishable. Successful storage of yams requires; initial selection of sound and healthy yams, proper curing, if possible combined with fungicide treatment, adequate ventilation to remove the heat generated by respiration of the tubers, regular inspection during storage and removal of rotting tubers and any sprouts that develop and protection from direct sunlight and rain[31,35,37,42]

Periodontitis and the Regenerative Potential of Yam

Chronic apical periodontitis (CAP) is a common inflammatory condition of the oral cavity, primarily caused by bacterial infection. It is characterized by persistent inflammation and bone resorption in the periapical region of the tooth, ultimately resulting in tooth loss if left untreated.Similarly, **periodontitis**, a severe form of gum disease, arises from the progression of untreated gingivitis and leads to the destruction of the supporting structures of the teeth. Clinical manifestations include gingival bleeding, swelling, halitosis, pain during mastication, increased tooth sensitivity, formation of periodontal pockets, and eventual tooth mobility and loss.A major challenge in managing chronic apical periodontitis is the **regeneration of the damaged periapical alveolar bone and periodontal tissues**. This remains a critical and unresolved issue in dental science. Current research efforts are increasingly focused on **tissue engineering and regenerative medicine** as potential solutions. In particular, **nanostructured biomaterials** offer significant advantages in bone defect repair due to their ability to mimic the nanoscale architecture of natural bone, thereby enhancing cellular interactions and promoting osteogenesis.[55,58,62,63,64]

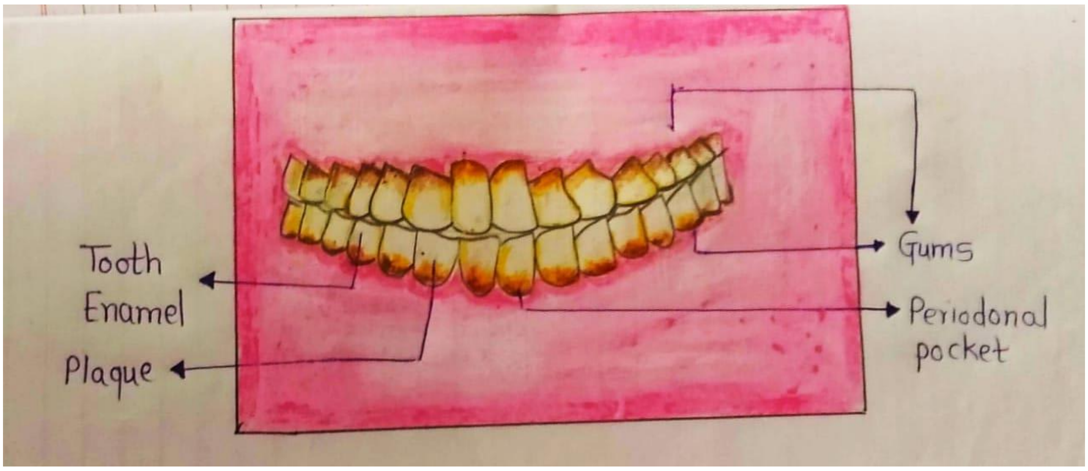

Fig No.3 External appearance

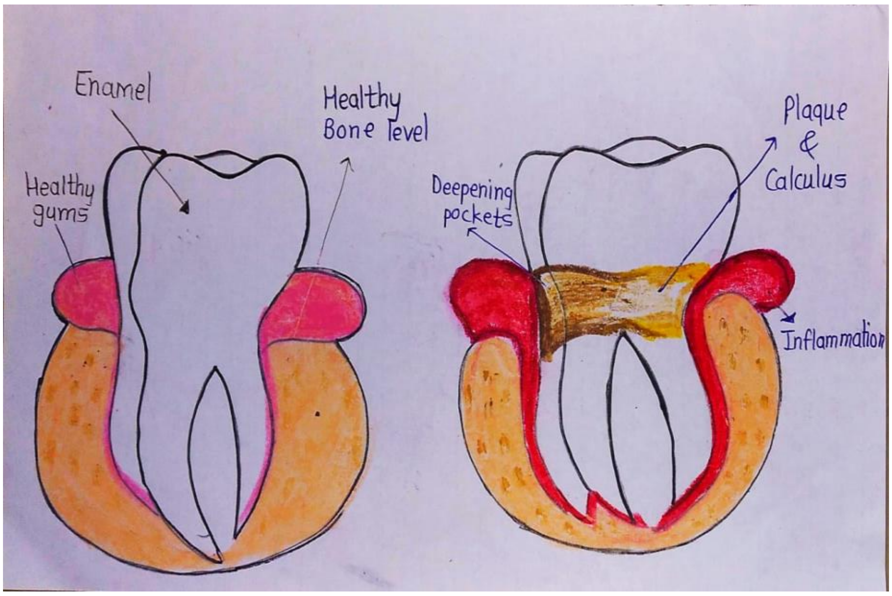

Fig No. 3. Periodontitis

Anti-inflammatory and Antioxidant Effects Traditional Chinese medicine recognizes **Chinese yam (Dioscorea spp.)** for its potent anti-inflammatory and antioxidant properties. These effects are highly relevant in the treatment of periodontitis, where chronic inflammation and oxidative stress play central roles in disease progression. [71,78,85,87,90]

Oxidative stress is known to impair osteoblast function and bone healing; therefore, the antioxidant activity of elephant foot yam may help create a favorable environment for bone formation and regeneration. Furthermore, the anti-inflammatory properties of the tuber may contribute to reducing inflammatory responses that can interfere with normal bone remodeling processes [93,95]. Recent studies have demonstrated the antimicrobial and antibiofilm activities of *A. paeoniifolius* extracts against oral and periodontal pathogens. These properties are particularly relevant in the context of periodontal tissue and alveolar bone regeneration, where microbial infection can impede healing and bone repair. Nayak reported significant antimicrobial activity of aqueous and ethanolic extracts of *A. paeoniifolius* against periodontal pathogens, demonstrated its ability to inhibit biofilm formation by early and late bacterial colonizers. By controlling microbial growth and reducing inflammation, elephant foot yam may indirectly support tissue healing and regenerative processes, including bone repair[93,95,97]

Nutritional and Biological Profile of Elephant foot yam is a major stable food for tribal populations, though its consumption is sometimes limited by acridity caused by calcium oxalate crystals. These crystals can cause a pricking sensation in the throat and may be a risk factor for kidney stones. Nutritional Contents in Yam (per 100g), Energy: 494 kJ (118 kcal), Carbohydrates: 27.9 g, Dietary fibres: 4.1 g, Protein: 1.5 g. The cellular mechanism of bone loss in periodontitis bone architecture is strictly maintained by a dynamic equilibrium between bone-forming **osteoblasts** and bone-resorbing **osteoclasts**. In a healthy oral cavity, these cells undergo continuous coupled remodeling. When a pathogenic, lipopolysaccharide (LPS)-rich biofilm establishes itself in the periodontal pocket or root canal apex, the immune system shifts this equilibrium[92,93,96]

The Cytokine Cascade: Invading macrophages and T-cells release a massive wave of pro-inflammatory cytokines,

The RANKL Pathway: These cytokines stimulate surrounding cells to upregulate **RANKL** (Receptor Activator of Nuclear Factor κB Ligand). RANKL binds to the RANK receptor on osteoclast precursor cells, triggering their proliferation and structural maturation into giant, multi-nucleated bone-devouring cells

Oxidative Stress Suppression: Simultaneously, the accumulation of Reactive Oxygen Species (ROS) damages the cells of the Periodontal Ligament (PDL) and induces apoptosis (cell death) in osteoblasts, blocking the body's natural capacity to rebuild bone matrix. [97,98,99,100]

CONCLUSION: This review highlights the significant potential of *Amorphophallus paeoniifolius* (Elephant foot yam) in bone regeneration, particularly in the context of periodontal diseases like periodontitis. As a chronic inflammatory condition that leads to the destruction of periodontal tissues, periodontitis poses a serious threat to oral health and can result in tooth loss. Current treatment approaches such as guided tissue regeneration and bone grafting aim to restore the lost bone and surrounding tissues. However, the exploration of herbal alternatives, especially those with bone regenerative properties, offers promising complementary or novel therapeutic strategies. The traditional and pharmacological significance of *A. paeoniifolius* suggests that it may serve as a valuable natural resource for promoting periodontal bone regeneration. Further research into its bioactive components and mechanisms of action is essential to validate its effectiveness and potential application in clinical settings.

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