



A Review on Multiple Potential of Aroid: *Amorphophallus paeoniifolius*

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ABSTRACT

Amorphophallus paeoniifolius commonly known as "Jimikand", "Elephant foot yam" is one of the underutilized aroid of araceae family. It is tuberous, stout indigenous herbs used in ayurvedic medicine system for treating various human ailments. In recent years the popularity of complementary medicine has increased. The present review compiles the existing literature related to botanical description propagation, nutrient composition, phyto-chemical constituents, traditional uses, pharmacological actions and production of value added products of *Amorphophallus paeoniifolius*.

Keywords: *Amorphophallus paeoniifolius*, Traditional Medicinal use, Value added products.

INTRODUCTION

A *Amorphophallus paeoniifolius* known as Elephant foot yam is a highly potential tropical tuber crop of Araceae family. It is an important tuber crop of tropical and sub-tropical countries because of its yield potential and culinary properties.¹ Elephant foot yam is widely grown and consumed in south eastern countries like India, Philippines, Malaysia, Indonesia. In India, it has gained the status of a cash crop due to its high production potential, market acceptability and lucrative economic returns with a production potential (50-80 t ha⁻¹).² It has a good source of protein as well as starch and is very popular as a vegetable in various Indian cuisines. In India, it is cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand. The net economic return is over 1 lakh rupees per ha. It has a great export potential since its commercial cultivation is not in other countries.^{3,4}

Local names of Plant

English (Elephant foot yam, Whitespot Giant Arum, Sweet Yam, Telinga Potato); Hindi name (Suranakanda, Zimikanda); Bengali name (Ole); Fijian (Suran); Japanese (Koniaku, Konjac, Konnyaku); Thai (Buk Khang); Tamil (*kizhangu*); Kannada (*suvarna gedde*); Oriya (*oluo*); telugu (*kanda gadda*).

Scientific Classification

Kingdom: Plantae
 Division: Angiosperms
 Class: Monocots
 Order: Alismatales
 Family: Araceae
 Genus: *Amorphophallus*
 Species: *paeoniifolius*
 Synonyms: *A campanulatus*

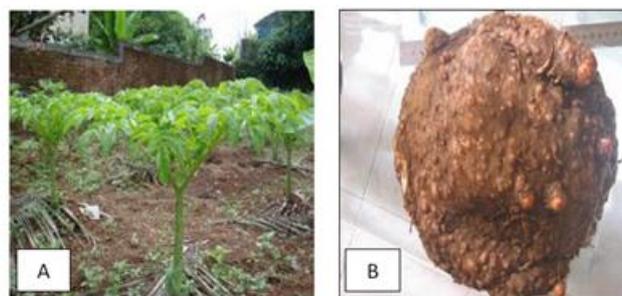


Figure 1: Photographs of *Amorphophallus paeoniifolius* [(A) Plant (B) Corm]

Ayurvedic properties

Rasa- Katu, Kashaya

Guna-Ruksha, Tikshna, Guru, Vishada, Laghu

Vipaka-Katu

Veerya- Ushna

*Karma- external-Shothahara, Vedanasthapana Internal-Arshaghna, Vatahara, Kaphahara, Yakrit-Uttejaka.*⁵

Botanical description

Amorphophallus is a perennial, terrestrial underground hemispherical depressed dark brown corm of approximately 20-25 cm in diameter which bears flowers and fruits in the month of April – May.^{6,7} It bears leaves that are solitary which are 30-90 cm broad; Inflorescence consist of a foliar organ, the spathe, which usually envelops a stalk-like organ, the spadix. The flowers are tiny, monoecious and strongly reduced and are found at the base of the spadix. Raphides of the *Amorphophallus campanulatus* Blume (syn. *paeoniifolius*) isolated from tuber are pointed at one end and square at other end, cross section is 'X'-shaped at pointed end and they are asymmetrical.⁸

Propagation, cultivation and storage

Hot and humid climate provides better growth of Elephant foot yam. Humid climate supports in the initial stages of crop growth where as dry climates facilitate tuber bulking. Well-distributed rainfall of 1000-1500mm is helpful for good crop growth and tuber yield. Well-drained, fertile, sandy-loam, black soil is ideal for elephant foot yam cultivation. Elephant foot yam is a long duration crop and generally matures in 6-7 months. Crop can be harvested at different stages of development starting from 6-7 months of plantation up to 4 years as per requirement. The crop is cultivated as a mixed crop in the fields of banana, ginger; groundnuts.⁹ Cut tuber pieces are used as planting material and take 3-4 weeks time for the development of sprouts. Plants can be vegetative propagated through corms which can be planted in the prepare pits (40cm x 40 cm x 40 cm) filled with decomposed cow dung compost and sandy loam soil.¹⁰ Tubers start sprouting after 2-3 months of storage. Tubers are stored in shaded, cool and ventilated place in single layer or in two –three layers with monitoring and removal of infected tubers, otherwise heavy rotting of tubers occurs.

TRADITIONAL USES OF CORMS

The tubers are a delicacy in food and rich in nutrients is much popular as a vegetable in various delicious cuisines. The tuberous roots of the plant possess blood purifier properties and have been used traditionally for the treatment of piles, abdominal disorders, tumours, enlargement of spleen, asthma and rheumatism.^{11, 12} They are traditionally used in arthralgia, elephantiasis, tumors, inflammations, hemorrhoids, hemorrhages, vomiting, cough, bronchitis, asthma, anorexia, dyspepsia, flatulence, colic, constipation, helminthiasis, hepatopathy, splenopathy, amenorrhoea, dysmenorrhoea, seminal weakness, fatigue, anemia and general debility. The tuberous roots of the plant have also been reported to possess tonic, stomachic and appetizer properties.¹¹

MAJOR NUTRIENT AND CHEMICAL CONSTITUENTS OF AMORPHOPHALLUS CORM

Amorphophallus is a good source of energy, sugar, starch, proteins as well as minerals. Average nutritional profile contains Starch (11-28%), sugar (0.7-1.7%), protein (0.8-2.60%), fat (0.07-0.40%) mean energy value (236-566.70KJ/100g). The most abundant macro mineral is potassium (327.83 mg/100 g) Phosphorus (166.91 mg/100 g), calcium (161.08 mg/100 g) and iron (3.43 mg/100 g). Macro mineral and soluble oxalate ranges between different varieties :K (230-417mg/100g)P(120-247 mg/100g) Ca (131-247 mg/100g) Fe(1.97-5.56 mg/100g) Mn (0.19-.65mg/100 g) Zn(.12-1.92 mg/100 g) Soluble oxalate(6.65-18.50 mg/100g).¹² The mean soluble oxalate content (13.53 mg/100 g) was safe from the viewpoint of accumulation of urinary oxalate leading to kidney stones.¹³

PHYTO-CHEMICAL SCREENING

Qualitative assay of different solvent extracts of *Amorphophallus paeoniifolius* was carried out for the presence of phytoconstituents. Extracts were taken of Petroleum ether, Chloroform, Methanol and water and tested for the presence of different phytoconstituents. The petroleum ether extract contains alkaloids, steroids, fats & fixed oil. The chloroform extract contains alkaloids. The methanol extract contains alkaloids, steroids, flavonoids and carbohydrates. The aqueous extract contains flavonoids, tannins, proteins and carbohydrates.¹⁴ Ethyl acetate and Hexane extract contains Alkaloid, flavones, carbohydrate and saponins.¹⁵ Methanolic extract (ME) and 70% Hydro-alcoholic extract (AE) of *Amorphophallus paeoniifolius* was analysed for flavonoid content (FC) in terms of Rutin and Total Phenolic Content (TPC) was measured in terms of catechol equivalent. Thin Layer Chromatography (TLC) study of methanolic extract was conducted. The flavonoid content of ME and AE were found to be 46.33 mg/g and 36.88 mg/g respectively. Similarly TPC of study extracts (ME and AE) were found to be 12.67 mg/g and 6.25 mg/g. ME showed higher contents of flavonoid and phenolic. Upon TLC of the ME it was observed that there were seven spots at different R_f values.¹⁵ A flavonoid (Quercetin) from the ethylacetate fraction of corm of *Amorphophallus paeoniifolius* was isolated by column chromatography using gradient elution method. The isolated flavonoid was characterized by spectral studies.¹⁶

MEDICINAL USES OF CORM

Gastroprotective ability

Free radical spices play an important role in gastrointestinal ulcerogenesis. Phytochemical constituents have shown the presence of polyphenols, which also possess anti-ulcer activity. Methanolic extract of *Amorphophallus* has shown gastro-protective ability against pylorus ligation induced gastotoxicity in albino rats. Methanol extracts of the corm have shown increased GSH levels and inhibition of lipid peroxidation in a dose-dependent manner i.e. 250 and 500 mg/kg. Treatment with methanol extracts showed reduction in gastric volume, free acidity, total acidity, pH and ulcer score. The protection percentage in a dose-dependent manner was, 250 mg/kg showed 67% and 500 mg/kg showed 85.5% activity respectively in comparison with standard Lansoprazole 80.50%.¹⁷

Analgesic activity

Oral dose of 250 and 500 mg/kg of methanol extract, showed significant analgesic activity in mice. The methanol extract suppressed dose-dependently the frequency of acetic acid-induced writhing in mice.¹⁸ Analgesic activity was also confirmed by tail flick method and acetic acid-induced writhing response method by using diclofenac sodium as standard. The intraperitoneal administration of methanol extract of *Amorphophallus paeoniifolius* tubers (250, 500 mg/kg) induced a



significant analgesic activity in a dose-dependent manner.¹⁹

Anticonvulsant Activity

Petroleum ether extracts of *Amorphophallus paeoniifolius* at the dose of 200, 300, 400 mg/kg were used for the effects on the onset of convulsion in isoniazid (INH) induced mice model. Diazepam at the dose of 4 mg/kg was used as the standard drug. The group pre-treated with standard diazepam had late onset of convulsion. Petroleum ether extract of *Amorphophallus paeoniifolius* in doses of 200, 300, 400 mg/kg significantly increased the latency of onset of convulsions. Petroleum ether extracts showed dose-dependent activity regarding onset of convulsion.²⁰

Antihelmintic activity

The methanolic extracts of the tubers showed antihelmintic activity against *Pheretima posthuma* and *Tubifex tubifex*. The extract with the concentrations of 25, 50 and 100 mg/ml were tested in the bioassay, which involved determination of time of paralysis and time of death of the worms. Methanolic extract showed dose dependent antihelmintic activity as compared to a standard drug piperazine citrate. The extract exhibited significant antihelmintic activity at highest concentration of 100 mg/ml. Piperazine citrate (10 mg/ml) was included as standard reference and distilled water as control. The extracts were found not only to paralyze (Vermifuge) but also to kill the earthworms (Vermicidal).²¹

Antidiarrhoeal activity

Swiss Albino rats of either sex weighing 150-180 g were used for study and anti-diarrhoeal activity was evaluated by castor oil-induced Diarrhoea model. The ethanolic extract of the *A. paeoniifolius* leaves, at the doses of 100, 200 and 400 mg/kg, reduced the total number of faeces as well as diarrhoeic faeces in a dose dependent manner and the results were statistically significant ($p < 0.05$). Ethanolic extract of *A. paeoniifolius* leaves exhibited a statistically significant reduction in the severity and frequency of diarrhoea produced by castor oil, which indicates to wide range of usefulness of this plant in secretory and functional diarrhoea.²²

Anti-inflammatory activity

Anti inflammatory activity was observed by using carrageenan induced paw edema model in rats.^{23,24} Among the petroleum ether, chloroform, methanol and water extracts the Methanol extract of *Amorphophallus paeoniifolius* has prominent anti-inflammatory activity while the chloroform extract has milder activity. Diclofenac sodium at the dose of 5 and 10 mg/kg were used as standard drug. 3 hours after the carrageenan injection, the methanol extract at the dose of 200 and 400 mg/kg produced 37.5% and 45.83% inhibition when compared to the control group represents the index of swelling. In case of control group where the maximum swelling index reaches up to 59.2 at 5th hour where as in

case of groups received diclofenac sodium 10 mg/kg and methanol extract 400 mg/kg the maximum swelling index were 16.02 and 23.29 at 2nd and 3rd hour respectively.²³

Methanol extracts of 200mg/kg and 400mg/kg with standard drug aspirin at the dose of 100 mg/kg also found to produce Anti-inflammatory activity. The effect of *Amorphophallus Campanulatus* tubers extracts was dose as well as time dependent, both extracts shows maximum inhibition at 180 minute [(200 mg/kg) 48.44 % and (400 mg /kg) 60.35%].²⁴

Antibacterial activity

Aqueous and organic solvent extracts of *Amorphophallus* were evaluated for its antibacterial potential by using disc diffusion method, against pathogenic strains of gram-positive bacteria (*Bacillus subtilis*, *Bacillus megaterium*, *Staphylococcus aureus*, *Streptococcus β -haemolyticus*) and six gram-negative bacteria (*Escherichia coli*, *Shigella dysenteriae*, *Shigella sonnei*, *Shigella flexneri*, *Pseudomonas aeruginosa*, *Salmonella typhi*)²⁵ and gram negative bacteria (*Escherichia coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa* and *Salmonella typhi*).²⁶ Chloroform and petroleum ether extract have shown antibacterial activity. The antibacterial activity of 3,5-diacetyltambulin, a flavonoid isolated from the chloroform fraction of *Amorphophallus campanulatus*.²⁷ Another report indicates the antibacterial activity of ambylone, a triterpenoid isolated from the petroleum ether soluble fraction of *Amorphophallus campanulatus*.²⁵ Different extracts differed significantly in their antibacterial properties with the benzene extract being very effective followed by petroleum ether, chloroform and ethyl acetate extracts. Aqueous and methanol extract showed very least activity.²⁶ Petroleum ether, chloroform and benzene extract has established good values on antibacterial activity against both gram-positive and gram-negative bacteria compared to the other extracts.

Antioxidant Activity

Antioxidant has a characteristic ability to trap free radicals. *Amorphophallus* species contains some kind of phytochemicals like polyphenols and flavonoid with antioxidative effect. Hexane extract and methanolic extract of *A. campanulatus* tuber were evaluated for phytochemical screening and in vitro antioxidant activities using DPPH, hydroxyl radical, reducing power and total antioxidant capacity assays. The total phenolic and flavonoid contents were also investigated. The protective potential of two different doses of methanolic extract (125 and 250 mg/kg) was also evaluated against thioacetamide (TAA) induced oxidative stress in rats. Silymarin used as a standard drug control. In vitro studies revealed that methanolic extract has higher antioxidant and radical scavenging activity than hexane extract, which may be attributed to its higher phenolic and flavonoid content. ACME significantly prevented the elevation of serum AST, ALT, ALP, LDH, and tissue malondialdehyde levels ($P < 0.05$). Hepatic and renal GSH, GST, GR, GPx, and catalase levels were remarkably increased by the



treatment with the extract. Quantification of histopathological changes also supported the dose dependent protective effects of methanolic extract.²⁸

Antioxidant activity and radical scavenging potential of ethanolic extracts of *Amorphophallus paeoniifolius* was studied for the inhibition of lipid peroxidation estimated in terms of thiobarbituric acid reactive substances (TBARS) and the levels were reduced by 4.3% to 67.2% in a dose-dependent manner. Methanolic extract was analyzed for scavenging capacities based on DPPH assay (1, 1-diphenyl-2-picrylhydrazyl-2-radical) and percentage inhibition activity based on 2,2-azinobis(-3-ethyl) benzo-thiozoline-6-sulfonate (ABTS+) and H₂O₂. The *A. paeoniifolius* extract showed a maximum of 68.6% of DPPH scavenging activity and the maximum inhibition of 74% and 67.2% in the case of ABTS and H₂O₂, respectively. The antioxidant efficiency and inhibition of oxidation of the extract was found to be dose-dependent at the tested concentrations of 1-50 microg/mL. High-performance thin layer liquid chromatography (HPTLC) profile of the extract suggests the presence of polyphenols such as gallic acid, resveratrol, quercetin and two unidentified compounds. The results suggest that the ethanol extract of *A. paeoniifolius* has a potent antioxidant activity in vitro and can be utilized as an effective and safe source of antioxidants.²⁹

Anti Tumour Activity

The ethanolic extract of *Amorphophallus Paeoniifolius* has shown significant antitumor and antioxidant effect in animals. Effect of ethanolic extract on RBC, WBC, Hb & Neutrophils as a-P< 0.001, b-P<0.01, c-P<0.05, ns-non significant, Effect of AP-extract on tumor latency and tumour burden were found as extremely significant at P<0.001. The present preliminary investigation suggests that *Amorphophallus paeoniifolius* tuber stimulate both cellular and humoral immunity.³⁰

CNS depressant activity

It was found that petroleum ether extract at doses of 100, 300 and 1000 mg/kg showed significant CNS depressants activity in mice the intra-peritoneal administration of petroleum ether extract of *Amorphophallus paeoniifolius* tubers (100, 300, 1000 mg/kg) induced a significant decrease in locomotor activity and grip test in a dose-dependent manner. The percentage decrease in locomotor activity are 16.53 ($P>0.05$), 56.77 ($P<0.01$), 73.36 ($P<0.01$) (n=6) and percentage decrease in activity in grip test are 10.38 ($P>0.05$), 62.67 ($P<0.01$) and 70.78 ($P<0.01$) (n=6) 1 hour after the intra-peritoneal administration of *Amorphophallus paeoniifolius* at the doses of 100, 300, 1000 mg/kg respectively.³¹ A significant synergistic effect of the petroleum ether extract of *Amorphophallus paeoniifolius* was seen with diazepam as compared to that of phenobarbitone.³² Effective dose (ED₅₀) for petroleum ether extract for the CNS depressant activity was calculated to be 250 mg/kg. Both of the phenobarbitone and diazepam exert their CNS depressant effect by acting on the GABAA receptor. So it was

concluded that the components present in the petroleum ether extract may bind with α subunit and facilitate the GABA mediated Cl⁻ channel opening, thus hyperpolarizing the cell and show CNS depressant action. Diazepam is a benzodiazepine receptor agonist it was concluded that extract has agonistic activity with benzodiazepine receptor, which might similar to that of diazepam. Further investigations need to be done to understanding of molecular mechanism of action and signal transduction of the components present in petroleum ether extract of *A. paeoniifolius* regarding CNS depressant activity.

Hepatoprotective activity

Amorphophallus paeoniifolius showed hepatoprotective activity against paracetamol and carbon tetrachloride induced liver damage in rats. The methanol and aqueous extract against paracetamol and ethyl acetate extract, aqueous and ethanolic extracts against carbon tetra chloride showed comparable reduction in the elevated levels of some serum biochemical indicators like serum glutamic pyruvic transaminase (sGPT), serum glutamic oxaloacetic transaminase (sGOT) and serum alkaline phosphatase (sALP), serum bilirubin (SB) similar to silymarin and Liv-52 as standard hepatoprotective agents.³³⁻³⁵

The biochemical observations with CCL4 treated induced liver damage were supplemented with histopathological examination of rat liver sections. The histological architecture of liver sections of the rats treated with aqueous and ethanolic extracts showed more or less normal lobular pattern with a mild degree of fatty change, necrosis and lymphocyte infiltration almost comparable to the control and silymarin treated groups.³⁵ Flavonoid was isolated from ethyl alcohol fraction by column chromatography using gradient elution method and showed hepatoprotective activity against carbon tetra chloride induced liver damage.³³

Immunomodulatory Activity

Methanol extract of *Amorphophallus campanulatus* tuber orally at doses of 250 and 500 mg/kg was investigated for immunomodulatory activity using charcoal clearance, spleen index and delayed-type hypersensitivity (DTH) response models. The extract exhibited immunomodulatory activity by causing a significant decrease in charcoal clearance, delayed-type hypersensitivity (DTH) response and spleen index. The methanol extracts of *Amorphophallus campanulatus* tuber significantly and dose dependently suppressed the immune system in mice.³⁶

INSECTICIDAL POTENTIALITY

Amorphophallus paeoniifolius Tuber, mannose specific Agglutinin (AMTL) showed conserved mannose binding domains, agglutinating ability of rabbit erythrocytes and insecticidal efficacies. The 25 kDa dimeric protein was found to inhibit the survivability of hemipteran insects. It was shown that insecticidal AMTL binds to insect gut brush border membrane vesicle (BBMV) protein,

conferring toxicity against target insects it can be a promising candidate in preventing crop loss caused due to hemipteran insect attack.³⁷

VALUE ADDITION

It is not only used as vegetables but recently several value added products like Pickles, dried cubes. Chips, thickening agents etc are also made and they are gaining popularity. Preparation of osmodehydrated slices from fresh corm,³⁸ and bread from flour of *Amorphophallus paeoniifolius* corm which is a good source of both carbohydrate and protein. It is reported that *Amorphophallus* corm flour (20 %) could substitute wheat flour in bread preparation (Unpublished data Singh et al). The wheat *Amorphophallus* composite bread in addition showed high content of calcium and dietary fibre. 1158.42 mg/100g, 2.49 mg/100g respectively (Singh et al unpublished data)

Singh et al have shown the presence of enzymes and phytochemical in outer peel of *Amorphophallus paeoniifolius*. Their studies confirmed the presence of alkaloids, tannins, phenols, carbohydrates and fat. Methanol and chloroform extracts gave higher yield of phenol (4.4, 3.9) (mg/g) gallic acid per g extract powder respectively and proanthocyanidin (2.17, 1.62) (mg/g) gallic acid per g extract powder respectively as compared to aqueous and petroleum ether peel extracts.³⁹ The therapeutic potency of the peel was also established by studying the antioxidative potential of these extracts by DPPH scavenging activity and phosphomolybdenum method. Thus Jimikand (*Amorphophallus*) peel wastes have high value products and important medicinal constituents.

CONCLUSION

Amorphophallus corm has been explored for their phytochemical, pharmacological and insecticidal activities. This review highlights the importance of *Amorphophallus* having multiple therapeutic potential. This crop has the ability to provide nutrition security to the developing countries along with their medicinal aspects. Thorough screening of literature available on *Amorphophallus* depicted the fact that it is a popular remedy among the Ayurvedic and traditional practitioners for treatment of various ailments. Molecular mechanism of action and signal transduction of the components present in petroleum ether extract of *A. paeoniifolius* regarding CNS depressant activity need to be addressed. AMTL is a promising candidate in preventing crop loss caused due to hemipteran insect attack AMTL to be enlisted as a promising insecticidal candidate protein effective against sap sucking insects. Insecticidal potential of other novel bio molecules from *Amorphophallus* can be explored. Leaves and peel of this crop are also need to be explored scientifically for their biological potential. Based on these facts, the authors hope that this review highlights the multifarious role of this neglected aroid that has great potential in novel drug discovery as well food crop.

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