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An Overview of the Phytopharmacology of the Significant Medicinal Herb *Amorphophallus paeoniifoliusv Linn*

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ABSTRACT

Amorphophallus paeoniifolius is used for long period in various chronic diseases therapeutically. Aim of the current review is to search literature for the pharmacological properties, safety/toxicity studies, pharmacognostic studies and phytochemical investigation of Amorphophallus paeoniifolius tuber. The compiled data may be helpful for the researchers to focus on the priority areas of research yet to be discovered. Complete information about the plant has been collected from various books, journals and Ayurvedic classical texts like Samhitas, Nighantus etc. Journals of the last 20 years were searched. Particulars of pharmacological activities, phytochemical isolation, toxicity studies etc. were extracted from the published reports focussing on the safety prole of the plant. Safety of the whole plant was concluded in the review Amorphophallus paeoniifolius is used for long period in various chronic diseases therapeutically. Aim of the current review is to search literature for the pharmacological properties, safety/toxicity studies, pharmacognostic studies and phytochemical investigation of Amorphophallus paeoniifolius tuber. The compiled data may be helpful for the researchers to focus on the priority areas of research yet to be discovered. Amorphophallus paeoniifolius has been utilised therapeutically for many years in the treatment of chronic disorders. Amorphophallus paeoniifolius tuber's pharmacological qualities, safety/toxicity tests, pharmacognostic investigations, and phytochemical investigation are the focus of the current review's literature search. The collected information might assist researchers concentrate on the most important fields that still need to be explored. Complete details regarding the plant have been gathered from a variety of books, periodicals, and classical Ayurvedic writings including Samhitas and Nighantus, among other sources. The last 20 years' worth of journals were combed. Information on pharmacological actions, phytochemical isolation, toxicity tests, and other topics were taken from published research that concentrated on the plant's safety profile. Following the examination, the overall plant's safety was determined.

***Key words**: Amorphophallus paeoniifolius, phytochemical, toxicity, pharmacological actions.*

INTRODUCTION

The significance of herbal remedies despite the great advancements in modern scientific medicine, the majority of people in developing nations, including India, still use traditional medicine as their main method of disease treatment. Even among those who have access to western medicine, the use of complementary and alternative medicine is rapidly rising globally. The spectrum of applications for medicinal plants has expanded as our understanding of human physiology and the metabolic process has increased. In 1997, the

World Bank published research (technical paper number 355) that made it clear that the importance of plant-based medicines has been growing globally.

On the market, about 50% of medications are comprised primarily of natural components. Interestingly, because many of the active components in therapeutic plants can't yet be manufactured synthetically, the market need for medicinal herbs is expected to stay high. [1] Regardless of the underlying philosophical basis, the use of plants in all major medical systems serves as an example of the universal function that plants play in the treatment of sickness. Consider the Unani (Islamic) and Ayurvedic (Hindu) systems, which are centred in western Asia and the Indian subcontinent, as well as those of the Orient. Western medicine has its roots in Mesopotamia and Egypt (China, Japan, Tibet, etc.).

In many cases, the details of how and when these medicinal plants were initially employed are lost to prehistory; in fact, animals other than humans seem to have their own materia medica. After the oral tradition of passing down medical knowledge, writing (such as the Egyptian Papyrus Ebers from around 1600 BC), baked clay tablets (660 conieform tablets from Ashurbanipal's library at Nineveh, now in the British Museum), parchment and manuscript herbals, printed herbals (the invention of printing was around 1440 AD), pharmacopoeias and other works of reference (the first London pharmacopoeia from 1618, the first British pharmacopoeias. Ayurvedic medicine (Ayurveda, 250–600 BC), Chinese medicinal herbs (text from the 4th century BC), and Unani medicine (Kitab-Al-Shifa, Avicenna's magnum opus, 98–1037 AD) all have comparable records [2].

According to estimates from the World Health Organization (WHO), around 80% of people who live in underdeveloped nations rely nearly entirely on traditional medicine for their main healthcare requirements. The medicinal plants are the foundation of almost all traditional medical systems and play a significant part in their success. About 2000 natural medicines are included in the Indian materia medica, practically all of which come from various folkloric and traditional systems.

Out of these medications made using the conventional method, 400 are made from minerals and animals, and the remaining 600 are made from plants. Indian traditional medicine has a long history, and traditional healthcare systems are thriving throughout the world. Recently, there has been interest in additional traditional medical products. Forskolin was obtained from Coleus forskohlii, a species used in ayurvedic preparation for heart diseases, and artemisinin was derived from Artimisia annua, a component of the Chinese antimalarial preparation Qinghaosu. Artemisinin is an active antimalarial chemical. For the treatment of drug-resistant malaria, a new standardized formulation called artemether has just been released, and similar analogues are currently undergoing testing for a number of applications. Traditional medicine plays a crucial role in providing healthcare. The fundamental healthcare needs of the population in developing countries are primarily met by indigenous traditional medicine. However, the majority of national health systems do not include traditional medicines, and the potential of the services offered by traditional practitioners is far from being realized. [3] The health of individuals and communities is greatly impacted by herbal medicines, but quality control measures still need to be established. The usage of herbal medicine has grown during the past ten years. As a result, there has been an upsurge in traditional use of herbal remedies and other traditional therapies.

There is now concern over how these various medications should be used. [3]. In recent years, the widespread usage of herbal remedies has given India an unique opportunity to

search for therapeutic lead compounds from a traditional medical system called Ayurveda that can be used for the creation of new drugs. Natural products make up about 50% of all modern medications, and they are crucial to pharmaceutical companies' efforts to produce new medications. [4]. Epidemiological data indicates that nutrition has a significant impact on health and how some chronic diseases, like cancer, are treated. [5,6] Some food sources include antitumor substances, and these substances are potential candidates for chemopreventive drugs to stave against the onset of cancer [7- 8].

The anticancer properties of plant-derived nutrients and nonnutritive elements have been demonstrated in a variety of in vitro and in vivo models [7], which has increased the focus on cancer prevention techniques that make use of these dietary variables. In India, traditional plant remedies and dietary regimens that are recommended by ayurveda and other indigenous medical systems are frequently used [10].

The global movement to promote patient safety is gathering steam, making medication safety a topic that is now much more important than ever. On the basis of chemical composition, the cultivation of medicinal plants with species created in a lab is being attempted and is anticipated to be utilised more frequently for commercial purposes. The effectiveness and safety of Ayurveda medications now on the market may be significantly impacted by these modifications. Therefore, a method must be established to address them [11].

Ayurvedic classic Charaka Samhita lists all drug side effects that can occur when they are prepared or used incorrectly. In order to reduce adverse reactions, Charaka also describes elegantly a number of host-related factors that must be taken into account when choosing medications, such as the patient's constitution (Prakriti), age (Vayam), disease (Vikruti), tolerance (previous exposure) (Satmya), psychological state (Satwa), and digestive capacity (Ahara-shakti), among others. [12]. It was stated that Vatsanabha (Aconite), maybe as a result of an overdose of Ayurvedic medications, may cause an adverse pharmacological reaction. [13] Ayurvedic medications seldom cause adverse drug reactions, making it challenging to identify these reports using an electronic retrieval system. The primary cause is the Ayurvedic doctors' inadequate documenting and reporting due to their ignorance of the communal use of this knowledge.

Plant Description

Indian Ayurvedic and tribal medicines frequently contain the tuberous plant Amorphophallus paeoniifolius (Dennst.) Nicolson (Syn. Amorphophallus campanulatus Blume ex Decne.) of the family Areaceae[15] [Figures 1 and 2].

Scientific Classification

Kingdom : Plantae
Phylum : Magnoliophyta
Order : Alismatales
Family : Araceae
Genus : Amorphophallus
Species : A. Paeoniifolius

Binomial Name

Amorphophallus paeoniifolius (Dennst.) Nicolson

Synonyms

A. campanulata or Elephant foot yam or Whitespot giant arum or Stink lily.

Fig.1:Amorphophallus paeoniifolius tuber

Fig.2: Plant of Amorphophallus paeoniifolius

General Description

English Name : Elephant foot yam
Bengali Name : Ol
Sanskrit Name : Suranah
Hindi Name : Suran,Jamikand
Parts Used : Corms

Traditional Uses

The corms have astringent, aphrodisiac, thermogenic, irritating, anodyne, anti-inflammatory, anti-haemorrhoidal, haemostatic, expectorant, digestive, appetiser, stomachic, anthelmintic, rejuvenating, and tonic properties. They can help with arthralgia, elephantiasis, tumours, inflammations, haemorrhoids, haemorrhages, vomiting, coughing, bronchitis, asthma, anorexia, dyspepsia, flatulence, colic, constipation, helminthiasis, hepatopathy, splenopathy, amenorrhoea, dysmenorrhoea, seminal weakness, [16]

The Plant's Morphology

A large, stout herbaceous plant with an underground, hemispherically-shaped, depressed dark brown corm. Male and female inflorescences are contiguous, neuters are absent, the spadix's appendage is subglobose or amorphous, equal to or longer than the fertile region, and the spathe is campanulate, pointed, strongly, closely veined, and externally greenish-pink. [17]

Distribution

The plant is grown extensively throughout India and can also be found in the wild in the Rampa Hills, Konkan, West Bengal, Assam, and the dekkan. Sri Lanka also cultivates it. [18, 19]

Qualities in Ayurveda

1) Rasa- Katu, Kashaya
2) Guna-Ruksha, Tikshna, Guru, Vishada, Laghu
3) Vipaka-Katu
4) Veerya- Ushna
5) Prabhava- Arshaghana
6) Doshaghnata- KaphaVataShamaka, Kapha-Vata Kara, Pitta-Hara, Kaphagna
7) Karma- external-Shothahara, Vedanasthapana
8) Internal-Arshaghna, Vatahara, Kaphahara, Yakrit-Uttejaka.

9) Rogaghnata-externally applied as paste with ghrita and honey in Sandhishotha, Shlipada, Arbuda, internal-Arsha,Pleeha, Gulma, Shwasa, Kasa.
10) Contraindication-Raktapitta
11) Dose- Powder 3-6 [20,21]

Preparations and formulations

1) Avahela and Paka- Sri BahusalaGuda
2) Churna - SamudradyaChurna
3) Vatika – Suranavatica [20,21]
4) It is media in the preparation of Tamra Bhasma
5) Loha - SuranavaLoha, Surana Modaka [20,21]

Siddha properties

1) SIDDHA name- KarunaiKilangu
2) Suvai (Taste)- Kaarppu (Pungent)
3) Veeriyam (potency)- Seetham (Cold)
4) Vipakam (Transformation)- Kaarppu (Pungent)
5) Gunam (Pharmacological actions)- Thuvarppi (Astringent), Ul Azhal Atrri (Demulcent)
6) Siddha pharmaceutical Preparations- KarunaiKilanguLehyam
7) Uses- Used in treatment of anorectal abscess, hemorrhoids.

Phytochemical Research

Using a dual-suppression-PCR approach, Santosa et al. in 2007 identified 19 polymorphic loci from A. paeoniifolius. These loci offer microsatellite markers with high polymorphism, with each locus containing three to 24 alleles. The observed and anticipated heterozygosities fell within the respective ranges of 0.521 to 0.854 and 0.766 to 0.930. This substantial allelic diversity suggests that the markers are appropriate for an *A. paeoniifolius* population research.[22].

Amorphophallus paeoniifolius (Dennst) Nicolson's methanolic extract (ME) and 70% hydro-alcoholic extract (AE) were both analyzed for their flavonoidal content (FC) in terms of rutin and total phenolic content (TPC) in terms of catechol equivalent. A methanolic extract thin layer chromatography (TLC) investigation was carried out. ME and AE both contained 36.88 mg/g and 46.33 mg/g of flavonoids, respectively. TPC of research extracts (ME and AE) was discovered to be 12.67 mg/g and 6.25 mg/g, respectively. However, ME was shown to have greater flavonoid and phenolic levels. Seven spots at various Rf values were found after the ME underwent TLC [23].

The corm of Amorphophallus paeoniifolius'sethylacetate fraction was used to isolate a flavonoid (quercetin) utilising column chromatography and the gradient elution method. Spectral analyses were used to describe the isolated flavonoid [24].

PHARMACEUTICAL RESEARCH

Paeoniifolius leaves underwent a thorough pharmacognostic morphological, anatomical, and quantitative microscopic analysis. [25-27]

Features on a Macroscale

The leaf is compound, solitary, with a thick, mottled petiole and a tripartite structure that is dorsiventral in nature, with no trichomes and only the epidermis, parenchyma, and sclerenchyma. Study was also done on the petiole's anatomical characteristics. As a gauge for

quantitative microscopical standards, the several leaf constants Stomatal number and Index, Vein islet and termination number, and Palisade ratio were calculated. Studies on morphology were conducted to identify the properties of leaves. Large, solitary, tripartite leaves with spreading segments and leaflets that are obovate or oblong, broad, sessile, acute, and oblique at the base. The veins are parallel and join to produce intra marginal veins at their ends.

Microscopic Characteristics

Transverse sections of the leaves and petioles were taken, stained, and used to study the anatomy. The dorsiventral nature of the leaf is evident in the transverse section, which also reveals a pronounced midrib and lamina connected to the adaxial part spreading laterally. The midrib is composed of a thin epidermal layer with thin-walled circular to rectangular cells, a central air chamber, and dense masses of parenchyma and sclerenchyma cells. While the sclerenchymatous cells are found in thick masses along the midrib's periphery, the air chambers, which can be circular or angular and range in size from wide to narrow, are situated in the centre of the leaf. The remaining area of the leaf is covered in polyhedral, thin-walled parenchyma cells, which contain calcium oxalate crystals and starch grains. The starch grains are simple and solitary, with a diameter of 10 to 20 m. the 70 m long and less than 5 m thick calcium oxalate crystals of raphides with pointy points seen in numerous tissues. In the centre, among the air chambers, there are around 10 tiny collateral vascular threads.

The dorsiventral lamina of the leaf is composed of a thick adaxial and a thin abaxial epidermis. Less of the cuticle is visible. Only the lower epidermis contains numerous paracytic (rubiaceous or parallel celled) stomata. The palisade cells of the mesophyll tissue are short, single-layered conical in shape, and the abaxial spongy cells are grouped in a few layers with many lobed and loosely spaced cells enclosing air chambers. Small elliptical collateral vascular bundles with parenchymatous bundle sheet can be seen in the later view. In cross section, the petiole is round and has two little adaxial wings. It comprises a thin, continuous layer of epidermis with walls that are square in shape. Inside the epidermis are many big masses of collenchyma cells, and inside those are compact, quite wide parenchyma cells. Wide circular air chambers are dispersed throughout the parenchymatous ground tissue at the centre. The vascular system is made up of central and peripheral strands, with the central strands being more or less dispersed amongst the large air chambers while the peripheral strands are located very next to the collenchyma. Steroids are present in the petroleum ether extract of *Amorphophallus paeoniifolius* tubers, according to a phytochemical screening. [25-27]

Pharmaceutical Research

Toxicity Studies

According to Dey et al (2009)'s research, using the petroleum ether extract at a therapeutic dose of 250 mg/kg is safe. In mice, the LD50 was discovered to be 2500 mg/kg.

Painkiller Action

Acetic acid-induced writhing reaction and the tail flick method in mice were used to measure the analgesic activity. At doses of 250 and 500 mg/kg body weight intraperitoneally, the methanolic extract of *A. Paeoniifolius* demonstrated substantial analgesic efficacy in a dose-dependent manner. Comparing the animal control group to the conventional medicine Diclofenac sodium, a substantial increase in analgesic activity was observed. [28,29]

Inflammatory-reduction Capacity

The anti-inflammatory effects of the *Amorphophallus paeoniifolius* methanol extract are more pronounced than those of the chloroform extract. In comparison to the control group, the methanol extract produced 37.5% and 45.83% inhibition 3 hours after the carrageenan injection at doses of 200 and 400 mg/kg. [30]

CNS Activities

Actophotometer and Rota-Rod equipment were used to assess central nervous system depressant action. At dosages of 100, 300, and 1000 mg/kg, petroleum ether extract was discovered to exhibit considerable CNS depressing effect in mice. Vehicle (10 ml/kg) intraperitoneally administered had no appreciable effect on locomotor activity. After 60 minutes, diazepam (0.5 mg/kg) did not significantly decrease locomotor activity (38.59% and 42.32%), whereas diazepam (1.5 mg/kg) significantly lowered locomotor activity (84.89% and 73.66%). Similar to diazepam, the intra-peritoneal administration of *Amorphophallus paeoniifolius* petroleum ether extract of tubers (100, 300, 1000 mg/kg) resulted in a significant reduction in locomotor activity and grip test in a dose-dependent manner.

More research has been done on the potential receptors for Amorphophallus paeoniifolius's central nervous system depressant activity resulting from synergistic drug interactions, and it has been discovered that pet-ether extract has more synergistic activity on the CNS depression with diazepam than phenobarbitone. With pet ether extract, diazepam, and phenobarbitone, a spontaneous dose-dependent CNS depressant action was seen in Swiss albino mice. The *A. Paeoniifolius* pet ether extract was delivered intravenously at doses of 100, 300, and 1000 mg/kg body weight. Pet-ether extract was found to have a percentage suppression of the CNS activity after 60 minutes that was 16.53%, 56.77%, and 73.36%, respectively. From the dose response curve, the effective dose (ED50) for the CNS depressant activity was calculated to be 250 mg/kg. Diazepam at the dose level of 0.1, 0.5, and 1.0 mg/kg bodyweight administered intraperitoneally. After 60 minutes, the percentage inhibition of the CNS activity was found to be 28.23%, 46.72%, and 91.6%, respectively. The effective dose (ED50) for the CNS depressant action was further estimated from the dose response curve to be 0.5 mg/kg. The intraperitoneal administration of phenobarbitone at doses of 0.5, 5, and 20 mg/kg body weight is comparable. Phenobarbitone's percentage inhibition of CNS activity was determined to be 11.11%, 25.68%, and 70.31%, respectively, after 60 minutes. The effective dose (ED50) for the CNS depressant action was determined from the dose response curve to be around 12 mg/kg. Vehicle (5% Tween 80) administered intraperitoneally at a dose of 10 ml/kg had no appreciable effect on locomotor activity. Additionally, the synergistic activity of pet-ether extract (250 mg/kg) and phenobarbitone (12 mg/kg) was examined. It was found that after one hour of drug administration, the percentage inhibition of CNS depressant activity of the combination was calculated to be 59%, which was found to be slightly higher than the percentage inhibition by pet-ether extract and phenobarbitone individually at their effective doses when compared with control group (vehicle).Comparatively, the synergistic activity of pet-ether extract (250 mg/kg) and diazepam (0.5 mg/kg) was examined, and it was found that after one hour of drug administration, the percentage inhibition of CNS depressant activity of the combination was calculated to be 75%, which was significantly higher than the percentage inhibition by pet-ether extract and diazepam individually at their effective doses (vehicle). [32]

Anti-microbiological Action

Amorphophallus campanulatus's tuberous roots' ethanol extract was tested for its antibacterial, antifungal, and cytotoxic properties. To assess the in vitro antibacterial and

antifungal properties, the disc diffusion technique was performed. The cytotoxicity of brine shrimp nauplii was established. Additionally, to assess antibacterial efficacy, the minimum inhibitory concentration (MIC) was established using the serial dilution method. The extract significantly inhibited the growth of six gram-negative bacteria as well as four gram-positive bacteria (Bacillus subtilis, Bacillus megaterium, Staphylococcus aureus, and Streptococcus - haemolyticus) (*Escherichia coli, Shigella dysenteriae, Shigella sonnei, Shigella flexneri, Pseudomonas aeruginosa, Salmonella typhi*). The MIC ranged from 16 to 128 g/ml against various microorganisms. The investigated fungus had a poor antifungal activity. The extract's LC50 value for brine shrimp nauplii in terms of cytotoxicity was 7.66 g/ml. [33]

Using the cup-plate diffusion method, the drug's various crude extracts were found to have additional antifungal and antibacterial activities against common pathogens such *E. coli, S. aureus, E. faecalis, K. pneumoniae, C. albicans, and A. fumigatus*. The methonolic extract of *6* was determined to be one of the most efficient extracts. [34]

Amblyone, a triterpenoid phytoconstituent from A. paeoniifolius, was evaluated for its in vitro cytotoxic, antifungal, and antibacterial effects. For in vitro antibacterial and antifungal screening, disc diffusion was used. The cytotoxicity of brine shrimp nauplii was established. Additionally, the antibacterial potency was assessed using the minimum inhibitory concentration (MIC) method of serial dilution. Large zones of inhibition against four Gram positive bacteria (Bacillus subtilis, basillus megaterium, Staphylococcus aureus, and Sreptococcus pyrogens) and six Gram negative bacteria were seen in disc diffusion antibacterial screening (*Escherichia coli, Shigella sonnei, Shigella flexneri, Pseudomonusaerogenosa and Salmonella typhi*). These bacteria's MIC values ranged from 8 to 64 micrograms/ml. In tests for antifungal activity, the chemical inhibited tiny zones of Aspergillus flavus, Aspergillus niger, and Rhizopus aryzae growth. The fungus Candida albicans was resistant to the substance. The compound's LC50 against brine shrimp nauplii in cytotoxic testing was 13.25 microgram/ml. [35]

Antineoplastic Action

The antihelmintic activity of the methanolic extracts of the tuber of *Amorphophallus paeoniifolius* against Pheretimaposthuma and *Tubifex tubifex* was studied. The bioassay, which involves timing the paralysis and death of the worms, was conducted on the extract at dosages of 25, 50, and 100 mg/ml. When the extract was at its greatest concentration of 100 mg/ml, it significantly reduced helminths. As a standard reference, piperazine citrate (10 mg/ml) was added, while pure water served as the control. The extracts were discovered to kill the earthworms as well as paralyse (vermifuge) them (Vermicidal). [35]

Histoprotective Function

Amorphophallus paeoniifolia's corm contains a flavonoid called quercetin, which Shashtry et al. extracted in 2010 and tested for hepatoprotective efficacy using a CCl4-induced model. The biochemical markers SGOT, SGPT, SALP, bilirubin, total protein, and histopathology of rat liver were all examined in relation to the flavonoid (quercetin). By lowering the increased enzyme levels, raising the protein level, and attenuating the damaged hepatocytes toward the normal texture, the outcomes were shown to be substantial. Histopathology of an isolated rat liver provided additional support for the findings. [24]

CONCLUSION

According to the analysis above, the plant is risk-free at its therapeutic dosage of 250 mg/kg. The plant was discovered to be a strong cytotoxic, antibacterial, antifungal, anti-

inflammatory, CNS depressive, anthelmintic, and analgesic agent. Additionally, it was observed that the CNS depressing effect of benzodiazepines may involve their receptors. Steroids and flavonoids are the major phytoconstituents found in the plant that are in charge of the effects. To identify the components accountable for the biological processes, more investigation is required. Additionally, it was noted that no clinical trials have been conducted too far. Therefore, it was determined from the current analysis of the literature and the ayurveda text that the plant has a significant therapeutic value.

The herb is exceedingly efficient and safe for use as medicine, according to traditional and ethnomedical literature. A potent and secure medicine from the plant can be examined for a variety of chronic ailments such liver disorders, cancer, arthritis, and other inflammatory diseases by employing the reverse pharmacological procedures in natural drug development.

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