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JALKUMBHI (*PISTIA STRATIOTES* L.): PHYTOCHEMISTRY, USE IN MEDICINES, PHYTOREMEDIATION, BIOGAS AND MANAGEMENT OPTIONS: A REVIEW STUDY

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Abstract

Pistia stratiotes (Family: Araceae) is commonly used in Ayurvedic medicine. This review article is a compilation of all the updated information on its phytochemical and pharmacological activities, which were performed by different methods. Studies indicate that P.stratiotes possessesdiuretic, antidiabetic, antidermatophytic, antifungal, and antimicrobial properties. These results are very encouraging and indicate that this plant should be studied more extensively to confirm the reproducibility of these results and also to reveal other potential therapeutic effects, along with some "leads" with possible isolation of active biomoieties and their mechanism of action.

Keywords: *Pharmacological activities, Phytochemistry, Pistia stratiotes*

Introduction

Mankind through observation and experience developed knowledge of the properties of plants as a source of food and medicines. Phytochemicals are as important as synthetic medicines since in some regions it is the only source of medicine. In the history of ancient civilizations, the use of medicinal herbs for curing diseases has been documented. Drugs were used in crude forms as decoctions, infusions, tinctures and poultices. Phytochemicals play an important role in the pharmaceutical industry as raw materials or as a particular drug. Secondary metabolites obtained from the plants are found to be an important source of various phytochemicals that could be used for the production of pharmaceuticals.

The use of plants as medicines predates written human history and some of the earliest written records from China, Egypt and Sumeria deal with this topic (Houghton, 1995). In Northern Nigeria, wild plants are consumed as normal herbs to provide fairly good amounts of several nutrients (Musa, 2005.) It is widely accepted that herbs are significant nutritional sources of minerals. Throughout the world, there is increasing interest in the importance of dietary minerals in the diet, even though they make up only 4-6% of the human body (Hassan et al., 2007). Traditional medicine is the sum total of knowledge skills and

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practices based on the theories, beliefs and experiences indigenous to different cultures that are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental illness (Cragg and Newman, 2001). Herbal medicines include herbs, herbal materials, herbal preparations and finished herbal products that contain parts of plants or other plant materials as active ingredients (WHO, 2008).

The plant was reported to have antifungal properties and antidermatophytic activity (Premkumar and Shyamsundar, 2005). The oil extract is used in the treatment of worm infestations, tuberculosis, asthma and dysentery and is applied externally to treat skin diseases, inflammation, piles, ulcers, syphilitic infections and burns (Kirtikar and Basu, 2002). The present use of *P. stratiotes* for the treatment of liver cirrhosis in the Northern part of Nigeria make this study important. The nutrient information and antioxidant properties reported in this study would enhance efforts to promote wide use of the plant because of its nutritional benefits and medicinal properties.

Distribution

Water lettuce is widely distributed in Pakistan in reservoirs, ponds, marshy areas, lakes and stagnant water bodies (Marwat et al., 2010). Being an exotic plant; the exact way and time of its introduction to Pakistan is unknown, but according to Stewart (1972), it was first time reported from Razmak, South Waziristan, Pakistan but now it can be found countywide up to 2500 meter altitude. Fawad et al.,(2013) reported that *P. stratiotes* L., was the most problematic and abundant weed in all habitats and water bodies of Swabi district of Khyber Pakhtunkhwa. On world level it is one of the most widely distributed hydrophytes in the tropics. It was first discovered from the Nile and presently it occurs in nearly all fresh bodies in tropical and subtropical regions. According to Holm etal., (1977) it has a cosmopolitan distribution and is considered indigenous in South and Central America, Africa and South-East Asia. It was introduced into Australia some 50 years ago. Gillet et al., (1988) are of the opinion that it is indigenous in the Northern Australia, where its natural enemies are regulating its population and has not been recorded at nuisance levels in this area, which creates the possibility that this area might be native for this plant.

Habitat: *Pistia stratiotes* grows in slow-moving rivers and reservoirs, irrigation channels, ponds, lakes, canals and ditches (Cilliers, 1991; Venema, 2001; Adebayo et al., 2011; Hussner et al., 2014). The species often invades rice paddies in Asia as well as other wetland habitats. *Pistia stratiotes* can survive drying and can re-infest ephemeral waters which are subject to seasonal drying because of seed survival and germination.

Pistia stratiotes is an aquatic plant, weed of stagnant water, can be more problematic in rice in the future (Marwat et al., 2010). It grows in a very wide variety of aquatic habitats. It requires a moist habitat, founds in lakes and rivers but prefers relatively stagnantwater. It can survive terrestrial condition by anchoring to the hydro-soil for a few weeks when the water level recedes. It is very sensitive to frost; the best range of temperature is 15-35°C (Rivers, 2002). It has a low salinity tolerance; salt concentrations of 1.66% are toxic to the plant (Haller et al., 1974).

Phytochemistry: Standard quantitativeanalyses of phytochemical constituents (such astannin, saponins, alkaloids, flavonoids,catechins, quinine and anthroquinones) werecarried out on the aqueous extract of *Pistiastratiotes* according to the method of Raaman(2006).The biologically active chemical constituents of *P. stratiotes* arealkaloids, glycosides, flavonoids,

and steroids. An analysis ofleaves and stems revealed the following: moisture 92.9%, protein1.4%, fat 0.3%, carbohydrate 2.6%, fibers 0.9%, ash 1.9%,calcium 0.2%, phosphorus 0.06%. Leaves are rich in vitamin Aand C, and also contain vitamin B. The ash is rich in potassiumchloride and sulfate. Stigmasta-4,22-dien-3-one, stigmasterol,stigmasteryl stearate, and palmitic acids are reported in *P. stratiotes.*Plant gave 2-di-C-glcosylflavones of vicenin and lucenin type,anthocyanin-cynidin-3-glucoside, luteolin-7-glycoside and mono-C-glcosyl flavones – vitexin and orientin (Khare,2005).

Utilization of Pistia stratiotes

Role in water purification: Pistia stratiotes L. is a 'hyperaccumulator' by removing heavy metals, organic compounds and radio-nuclides from water (Sinha et.al., 2006) It purifies the polluted aquatic system from deterimental metals. Lower size of the plant for removal of heavy metals is a credit for this plant as compared to water hyacinth (Quinones et. al., 2006, Sinha et. al., 2009, Mufarrege et al. 2010, Singh and Sinha, 2011). It can be used for Zn extraction from industrial wastes as it has strong affinity to Zn absorption in an ecofriendly manner (Nurhayati et. al., 2012) The same is true about mercury too (Skinner, 2007). The accumulation of heavy metals like Fe, Zn, Cu, Cr, and Cd does not cause any toxic effect on the plant which qualifies the plant to be used for the phyto-remediation of waste water for heavy metals on large-scale (Mishra and Tripathi, 2008). *P. stratiotes*is best candidate for in situ bioremediation of drug contaminated water body as it is more sensitive than the other aquatic plants tested. Thus it is recommended for quinolone bioremediation but less effective for sulphonamide (Forni et. al., 2006).

Biological and pharmacological activities

Anti-inflammatory activity: Water lettuce is traditionally used for curingopthalmia and iritis in Ghana, due to its analgesic anti-inflammatory effect(Kumar et al., 2011, Tripathi et al., 2010,Abbiw, 1990, Arber, 2002). Its water and ethanolic extracts given in acute inflammation relieve hyperalgesia by inhibiting the chemicals (histamine,serotonin, prostaglandin and bradykinin) that stimulates and sensitizes the nociceptor (Koffuor et al., 2012).

The phytochemical screening revealedpresence of someflavonoids and sterols, which might be the source of the anti-inflammatory activity of this plant (Pelzeret al.,1998, Funakoshi et al., 2011).

Diuretic activity: *Pistia stratiotes* Linn. is the aquatic plant obtained abundantly in ponds, river and streams with a different morphological characteristics, Leaves are oblong speculate with light green color on the upper side and whitish color on the underside. Roots are feathery and sag freely on water. Plant is rich in alkaloids, Glycosides, flavonoids and phytosterols, sterols, leaf and stem is rich in water, protein, carbohydrates and vitamin A and C.Leaf extract of this plant is used to treat leprosy, eczema, ulcer piles and syphilis and many more, the diuretic activity of *Pistia stratiotes* Linn. is studied in Lipchitz method by using Wistar albino rat. Ethanolic extract of *Pistiastratiotes* ability to block sugar absorption and it is also increase bulk of urine, regulate the body electrolyte. Result reveals that extract of Pistia stratiotes significantly shows diuretic activity (Khan et al., 2014).

Anti-microbial activity:

Wound healing potential:Plants have compounds that help the wound to heal quickly (Kalyon et al., 2009). Pistia stratiotescontains large amount of compounds that have antioxidant activity (Zennie & McClure, 1977). For example sterols from this plant are reported to be

responsible for wound healing property of the plant (Ayyad, 2002). Tremendous research has been conducted for the discovery of new antioxidants from herbs to prevent damage from free radical (Chen et al., 2011; Huang et al., 2011). In this regard topical application of water lettuce plant material at the wound increased wound healing significantly. The healing potential might be due to its ability to trigger angiogenesis and mitogenesis at the site (Gupta et al., 2009). The antioxidant property of any substance is believed to promote wound healing resulting in skin regeneration. The antioxidant activity of water lettuce extract is well known, which prevents oxidative damage and encourages the process of healing.

Allelopathic effects on terrestrial plants:

The allelopathic potential of water lettuce is a best sourcefor weed management. Screening provides important basicinformation on inhibitory effects and their potential for weedcontrol (Macias et al.,2007). Some alello chemicals caused root cell deathindirectly by production of reactive oxygen species that worked as signalling molecules that changed hormonalbalance during seed germination(Bogatek and Gniazdowska, 2007). Germination of lettucein aqueous extracts of corn residues, caused necrotic root tipsand shorter roots due to damage of meristematic tissue(Chou and Patrick, 1976).Eucalyptol also inhibits the roots growth of lettuce seedlings (Romagni et al., 2009).

Effect of aquatic weeds on environment

Aquatic weeds in submerged fields and cultivable terrains threaten agricultural production, costs, and quality by competing for resources like water, nutrients, and sunlight, leading to inundation and sedimentation. Aquatic weeds encourage mosquito proliferation by offering cover and protection from predators, which helps to transmit diseases like encephalitis, yellow fever, malaria, and river blindness. Aquatic weeds have a substantial negative impact on fish output because their dense growth, which covers entire water bodies, prevents fish from getting enough oxygen, suffocates them, and finally kills them. Large amounts of organic matter are broken down by aquatic weeds, creating carbon dioxide and carbon monoxide that give off obnoxious odours and make it difficult for boats to move. They affect water bodies like lakes, dams, and tanks by slowing water flow, allowing. Marginal weeds (a-c). silt to settle, and doing so. They decrease concrete construction strength, impair taste and odour, and raise biological oxygen requirement. Additionally, they restrict water movement, increasing seepage and raising the water table, which results in saline or alkaline soil conditions. Weeds that are floating and submerged spread quickly, forming dense mats that can seriously harm bridges and other structures. (Jayan and Sathyanathan, 2012).

Management of Pistia stratiotes

Physical/mechanical control: Water lettuce removal by hand or racking is a practical control method often used for small areas or when numbers are low. The use of water weed harvesters may also be used in larger areas. Physical removal is most effective for small infestations and should be made before flowering and seeding. Mechanical control of water lettuce can help take advantage of flooding or water flushes that deposit water lettuce in dams, lagoons and calm water areas of rivers and creeks. When using this approach it is essential water lettuce is removed before its rapid growth commences. Water lettuce can survive if it is deposited or left on moist banks it. To help prevent the reintroduction of water lettuce into the watercourse, it is essential it is moved from the water’s edge.

Chemical control: Water lettuce can effectively be controlled by sulfonylurea herbicides like chlorsulfuron (Madin, 1984) and contact herbicides like paraquat and diquat (Thayer & Haller, 1985) and non-selective systemic herbicide like glyphosate (Thayer & Haller, 1985; Van *et al*., 1986), a mixture of diquat and triclopyr (Langeland & Smith, 1993), terbutryn (Vermeulen *et al*., 1996), 2,4-D (Langeland & Smith, 1993) and endothall (Rivers, 2002). However chemical control endangers the environment and should be avoided for a better alternative approach if possible. As it will suspend the use of water for a considerable period and disturb the balance of the aquatic ecosystem by negatively affecting other plants and animal lives. It may create health hazards for the local people and birds specially in developing areas. In indispensable situation special formulation with low mammalian toxicity should be used as AF101 (Parsons & Cuthbertson, 1992).

Biological control: N A weevil (Neohydromonusaffinis) has been introduced and exert good control in some areas. The weevils have proved effective on dams from Bundaberg to Brisbane. The life cycle of the weevil takes about three months. Eggs are laid in the fleshy leaves and the larvae tunnel through the plant tissue. The openings assist the entry of fungi and bacteria, causing the tissue to rot. Biological control is most effective on large infestations, but it may take several years to achieve satisfactory control if used in isolation from other methods. To establish an effective breeding population of biological control agents, infested plants should be placed in an area where the water lettuce is concentrated. Your local government or Biosecurity Queensland can assist you with protocols and information on the collection site nearest to you.

Conclusion

P. stratiotes containalkaloids, glycosides, flavonoids, and steroids, vitaminA, B and C, proteins, essential amino acids, andminerals. Its leaves are used in traditional medicine fortreatment of ringworm, syphilis, skin infections, boils,wounds, fever, tuberculosis and dysentery in manycountries of the world. *P. stratiotes* posses variousbiological activities like antibacterial, antioxidant, bronchodilatory, antitumor, antidermatophytic, antifungal, diuretic, antiprotease, antidiabetic andantimicrobial. It is allelopathic causing harmful effectson other plant through allelochemicals. Favorable condition and nutrient enrichment in the water bodiesmakes it an invasive plant and necessitates its controlthrough physical, chemical, or biological methods.Further study on the isolation and identification of thevarious bioactive compounds, its role in bioremediationand different methods of its control isstrongly recommended.

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