

PROSPECTS OF NOXIOUS WEED EICHHORNIA PLANT

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Abstract: Eichhornia is considered a worst and invasive aquatic weed, due to its high rate of growth and propagation capability. On the other hand, it has enormous applications in different areas of science and utilized for various research activities. Rapid spreading of this aquatic plant can be reduced by demonstrating its values and turn it to beneficial uses. The present review is focused on the restating of literatures related to the diverse utilization of Eichhornia plant in various fields like Biomedical, Environmental, Agricultural, Bio-nanoscience etc. The hope and prediction of use of Eichhornia plant enlighten a way for solving future problems and bringing advantages to various fields of science.

IndexTerms:- *Eichhornia crassipes*, water hyacinth, phytoremediation, antibacterial, nanoparticle synthesis.

INTRODUCTION

Eichhornia crassipes (mart) Solm. is a free floating, invasive nuisance weed commonly known as water hyacinth, which is native to Amazon basins. Most of the world's aquatic area is infested by this plant (Holms *et al.*, 1997). Highly noxious nature of Eichhornia plant made to be enlisted among the world's worst 100 invasive weed (Lowe *et al.*, 2000). As it is native to Amazon basins it is spread all over the continents except Antarctica. Rapid growth rate and highly adaptive nature towards extreme conditions is the main reason for its invasive nature (Hill *et al.*, 2011).

It is a monocot perennial & free floating plant except when it is grounded in mud. Its size varies from centimeters to over a meters in height (Westerdahl and Gtsinger, 1988). Leaves are oval to elliptical, glossy nature across on stem. Petiole is inflated, bulbous and spongy in nature that helps for buoyancy. Roots are feathery, free hanging and purple-black coloured. Flowers are blue-purple colour born on upright spikes. (Télez *et al.*, 2008).

Socio-economic problems

Eichhornia sp. can compete with other aquatic plants and easily spread over the public water bodies. Its rapid growth and propagation form a dense floating mat that spread over water bodies and significantly harm boat navigation, clogging of river, oxygen depletion, causing the growth of other aquatic organisms, mechanical damage to hydro-electric projects and structures like large bridges. (Scalera *et al.*, 2012 & Coetzee *et al.*, 2017).

Prospects of Eichhornia

Besides its negative impact on the environment, Eichhornia sp. is a very auspicious plant with tremendous applications. There are various studies reporting the usefulness of this weed. Understanding the prospects of Eichhornia is essential for its effective utilization for the economic and ecological benefits (Jafari and Trivedy, 2005). This review article is mainly focusing on the possibilities and expectations of Eichhornia plant in solving future problems not only in turning of waste into treasure but also bringing some benefits to various fields of science.

BIOMEDICAL APPLICATION

Eichhornia crassipes possess medicinal properties due to the presence of a fountain of phytochemicals. Secondary metabolites like flavonoids, alkaloids, tannins and phenols present in the leaf extract shows biological activities such as antiviral, antifungal, antitumor and antibacterial activities (Haggag Wafaa et al., 2014). Doughari (2006) investigated that the presence of alkaloids in plants are responsible for antibacterial activity. Haroon (2006) describes the antimicrobial activity of water hyacinth which is due to the presence of tannins, flavonoids, alkaloids and saponins. The studies of Chukwuka *et al.*, (2011) support this. According to Zhou *et al.*, 2009), the antimicrobial activity of plant extracts also depends on the factors like pH, concentration and action time.

ANTIMICROBIAL ACTIVITY

There are various reports that reveals the antimicrobial potential of the extracts of Eichhornia plant against a wide range of micro organism that includes bacteria, actinomycetes and fungus. Zhou *et al.*, 2009), showed the inhibitory effect of Eichhornia plant extracts on *Staphylococcus aureus*, *Escherichia coli*, *Penicillium* and *Aspergillus niger*. Vadlapudi (2010), investigated the antifungal activity of methanolic extract of this plant against *Alternaria alternata*, *Aspergillus flavus*, *Fusarium oxysporum*, *Rhizoctonia solani*, and *Xanthomonas compestris*. Lalitha et.al(2011) also observed the ability of crude extracts and fractionates of Eichhornia to inhibit the growth of fungal sp. like *Monascus ruber* and *Aspergillus fumigates* and bacterial sp. like *Micrococcus luteus* and *Rhodospirillum rubrum* .For their study they used aqueous and chloroform fractionates and the ethanol and ethyl acetate extracts. Kumar et al (2014) reported the inhibitory action of Eichhornia extracts against the growth of gram positive bacterias such as *Bacillus cereus*, *Streptococcus mutants* and gram negative bacteria *Proteus vulgaris*, *Salmonella typhi* and *Bordetella bronchiseptica*. Taqi. J.Z *et al* (2017) observed the inhibitory property of the ethanolic leaf extracts of Eichhornia against bacterial strains such as *E.coli* and *Staphylococcus aureus*.

ANTICANCEROUS ACTIVITY

Eichhornia plant is suggested as a cancer medicine due to its safe and tumor inhibition potential (Huma *et al.*, 2009). Kumar *et al.*, (2013) reported that the cytotoxic and cancer chemo-preventive effects of this plant is because of the presence of flavonoids, terpenoids and alkaloids. As stated by Aboul-Enein *et al.*, (2014) Eichhornia which contain compounds having anticancer properties. According to Various reports states the potential anti cancerous property of different fractions of extracts

of Eichhornia plant. Aboul-Enein *et al.*, (2011) observed that the crude extract of Eichhornia exhibits a significant anti cancerous activity against liver cancer cell line and hormone depended tumor type (breast cancer). Different doses of methanolic extract of water hyacinth shows antitumor activity against B16F10 *in vivo* melanoma tumor bearing hybrid mice models (from Swiss albino female and C57BL male (Ali, 2009). Lenoraa (2015) investigated that the methanolic extract of Eichhornia reveals a mild anti cancerous activity on human cervical cancer cell lines, He La. The potential of aqueous fraction of leaf extracts of Eichhornia plant was reported by Kumar *et al.*,(2014) which shows its cytotoxic effect against NCI-H322 (lung) cell line and T47D (breast) cell line. Taqi *et al.*, (2019) demonstrated the anti cancerous property of ethanolic leaf extracts of Eichhornia against the breast cancer cell line (MCF-7).

ANTIOXIDANT ACTIVITY

Compound which inhibit cell organelles damage from free radicals induced oxidative stress that is either by inhibiting the initiation or propogation of oxidative chain reaction are antioxidants (Mishra *et al.*,2011) Eichhornia an aquatic weed which contain rich amount of oxidative enzymes and non enzymatic antioxidant systems (Thamaraiselvi *et al.*,2012). Haggag Wafaa *et al.*,(2014) reported that the phenolics and antioxidants present in water hyacinth exhibits chemical defence against plant pathogens. Eichhornia reported for its pharmacological properties of ethano-medicinal importance due to the presence of antioxidant, phenolics and flavonoids in the methanolic extract of its different plant part. Jayanthi and Lalitha (2011), studied the comparison of antioxidant power of different solvent extracts of Eichhornia with standard antioxidant L- Ascorbic acid. It was found that the reducing potential of Eichhornia extracts was greater than the natural antioxidants, The Antioxidant activity of extracts of the light petroleum, acetone, ethyl acetate, aqueous, and hydrolyzed extracts become evaluated with the aid of DPPH assay was mention by Jayanthi & Lalitha (2012). According to them the hydrolyzed extracts of Eichhornia shows good DPPH scavenging activity.

ENVIRONMENTAL APPLICATION

REMOVAL OF HEAVY METALS & WASTE WATER TREATMENTS

Phytoremediation is an environmental tool for the removal of toxic heavy metals, nutrients and other pollutants from polluted or contaminated water. Phytoremediation is one of the most feasible method for the treatment of industrial effluent and municipal waste water. Aquatic macrophyte, water hyacinth have a special significance of accumulation property. Hence the plant is considered as the eminent tool for the removal of heavy metals and other pollutants from water because of well developed fibrous root system and large biomass. It can able to reduce the level of organic and inorganic nutrient and thus can improve the quality of water (Delgado *et al.*, 1995). Falbo and Weak, (1990) reported that water hyacinth reduces levels of heavy metals in acid-mine water with little signs of toxicity. Trace elements such as Ag, Pb, Cd, *etc* can accumulated by water hyacinth and is efficient to remove pollutants with Cd, Cr, Cu and Se from waste water (Zhu *et al.*, 1999). Biosorption efficiency of the water hyacinth in the removal of various pollutants present in textile waste water

was enumerated. water hyacinth has high removal rates for various dye stuffs and heavy metals like iron (Fe), zinc (Zn), copper (Cu), chromium (Cr), cadmium (Cd), manganese (Mn), mercury (Hg) and arsenic (As) from aqueous solutions (De Casabianca and Laugier, 1995; Maine *et al.*, 2001; Mangabeira *et al.*, 2004; Sim, 2003) and also have the potential to reduce water pollution level through the absorption of nutrients and other substances from water. Priya *et al.* (2017) reported that water hyacinth is a good candidate for pollutant removal or even as a bio indicator for heavy metals in aquatic ecosystems. Eichhornia have been used to remove effluents within the range of 750-850mg/l and thus they can be used in waste water treatment (Rajendra B. Magar *et al.*, 2017).

AGRICULTURAL APPLICATIONS

ANIMAL FEED

It is observed that the plant eichhornia contain enormous quantity of nutrients and minerals all the year around, and possess high content of protein and minerals marked as a good source of animal feed. Studies demonstrates that the nutrients in this plant are available to ruminants (Wolverton and McDonald, 1979). In developing countries the use of Eichhornia as animal feed help to solve some nutritional problems (Jafari, 2010). The fresh mass of water hyacinth have been used as Pig fodder in China (Ding *et al.*, 2001). Akinwande *et al.*, 2013 studied the biomass yield, Chemical composition, nutritional potential of *Eichhornia crassipes* in three water bodies in Nigeria able to used as ruminant feed. Eichhornia which combines with other concentrates of high energy feed it improves the nutritional value and digestibility of the feed (Aderibigebe and Brown, 1993; Ojeifo *et al.*, 2000).

FISH FEED

In china and Thailand fishes such as Chinese grass carp, tilapia, silver carp and the silver dollar fish are used to control aquatic weeds. Utilizing this quality Eichhornia is used as fish feed (Jafari, 2010). Gopal, 1987 reported that the addition of hydrated water hyacinth increases the growth rate of channel cat fish fingerlings. The fermented water hyacinth was used as fish feed in nursery ponds in Vietnam which increases the growth rate of grass carp, Java barb and common carp (Tuan *et al.* 1994).

FERTILIZERS AS COMPOST OR VERMICOMPOST & INSECTICIDES

Water hyacinth was used as either compost or vermicompost (Gajalakshmi *et al.*, 2002). It is an ideal plant for composting. The fertilizer enhances soil fertility and crop yield and is usually boost the quality of the soil (Henrylito D., 2001). Water hyacinth was mixed with municipal waste ash and soil and then it composted and sold to local farmers and gardeners of Sri Lanka (Kumar 2012). Lenora *et al* 2017 reported the insecticidal potential of methanol and n-hexane extracts of aerial part of Eichhornia on Tobacco caterpillar, *Spodoptera litura* (F).

BIOGAS PRODUCTION

Eichhornia is an excellent source of biomass. Curtis and Duke (1982) reported that 1kg dried weight of Eichhornia can yield 370 litres of biogas compared to pure methane. From semi dried Eichhornia plant can yield 4000 litres of gas per tone as it being produced with a methane content of 64 percent (Gopal, 1987). Along with animal wastes, harvested water hyacinth was also used for the production of biogas.

APPLICATION IN NANOTECHNOLOGY -NANOPARTICLE SYNTHESIS

Nanotechnology is a recent area of science deals with the controlled synthesis of nanoparticles possess physical, chemical, electrical, magnetic, structural, morphological and optical properties having a vast range of applications in various fields of science. Different methods are there for the synthesis of nanoparticles; chemical, physical and biological methods. Among these biological or green synthesis is a safe approach. On that context, Phytonanotechnology is a new route for the synthesis of valuable eco-friendly nanoparticles. The synthesized nanoparticles using universal solvent (water) has advantages includes biocompatibility, scalability and medical applicability (Noruzi, M. (2015)). Plants are preferred over microbes due to the easy way of processing and are more economical. Biomolecules and the secondary metabolites present in plants act as capping and stabilizing agents for the synthesis of nanoparticles as well as it provide a significant role in metal reduction (Duan, H. et al. (2015)).

Eichhornia plant extracts is used as a source for the eco-friendly synthesis of different types of nanoparticles. Due to medical applicability, biocompatibility and scalability of synthesized nanoparticles are suitable for fulfilling the high demands of nanoparticles in the biomedical and environmental sectors. *Eichhornia crassipes* have been explored for the synthesis of Copper oxide (Vanathi et al 2016) nanoparticle which shows antimicrobial activity against *A. hydrophila*, *S. pyogenes*, *S. aureus*, *E.coli*, *A. flavus*, *F.culmorum* and *P. aeruginosa*, Gold nanoparticles (Munive- Olarte et al 2017; Abbasi T et al 2016) which is applicable in drug delivery, bio-imaging and biosensing areas, Silver nanoparticles (Thombre et al 2014; Prabhakaran & Mani 2017; Prusty A.K 2011) is suited for the production of antimicrobial drug and has an anticancerous property, Iron (Yufen Wei et al 2016) nanoparticles are applicable in the field of remediation and waste water treatments, Manganese Oxide (Blanco et al 2016) nanoparticle are used as biosensor, catalysts and bioimaging processes. Zinc Oxide (Vanathi et al 2014; Santhoshkumar et al 2017; Rajive et al 2018) nanoparticles synthesized using *Eichhornia crassipes* have potential application in Biomedicine mainly in anticancer and antimicrobial areas.

OTHER APPLICATIONS

Nolad 1974 reported the use of eichhornia plant for the large scale and small scale production of paper. This was successfully implemented in countries like Philippines, Indonesia, and India. In Phillipians dried Eichhornia plant is used for the making of basket for domestic use. Weaving skill is necessary for the preparation and in India similar products like bags, footwear, wreaths, hats, vases, Christmas lanterns, and more decorative materials are made in relation to tourism. Strong fibres from the

stem of water hyacinth is used as ropes .northern states of India the rope is utilized for making furnitures. It is also used as ornamental plant.

CONCLUSION

Eichhornia considered as the most reproductive plant on earth grows rapidly and have a greater reproductive capacity. Its rapid growth influences the reduction of nutrient and oxygen content also affects the growth of flora and fauna in water. High reproductive capacity of this plant causes serious socio-economic problems. Considering its beneficial aspects it has the potential to be utilized in various fields. Water hyacinth is a major resource for valuable phytochemicals which is an advantage of this plant used in medicinal fields. Heavy metals, mineral and nutrient accumulation property of Eichhornia is explored in the field of phytoremediation. Eichhornia is applied in Agricultural fields because of the presence of excess amount of nutrient content in its biomass makes a possible food sources for animals ; excellent source for essential oils and secondary metabolites used as insecticides and biopesticides. High biomass production of this plant is used as a raw material for biogas production. Due to the presence of biomolecules and secondary metabolites present in Eichhornia is used as a tool for the synthesis of different metal nanoparticles based on green method. Various beneficial aspects of Eichhornia realizes that can change noxious plant into a promising plant by utilizing its assets of diverse applications in various fields of science.

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