AQUATIC MACROPHYTES ROLES IN NUTRIENT AND HEAVY METAL REGULATION

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ABSTRACT

The activities of man have directly or indirectly influenced the aquatic ecosystem by increasingly polluting wetlands. Water quality influences the growth of fish. The utilization of aquatic weeds for the recovery of nutrients and heavy metals in polluted wetlands is a proffered management strategy. This paper reviews the role of aquatic macrophytes in nutrients and heavy metal sequestering.

INTRODUCTION

Aquatic macrophytes are plants growing on water, on submerged soil or on soil that is saturated with water (Agbogidi et al 2000). Aquatic plants affect water adversely by blocking canals and pumps in irrigation project, interfering with hydroelectric production, wasting water through evapotranspiration, hindering boat traffic, increasing water borne diseases, interfering with fishing and fish culture; and clogging rivers and canals so that drainage is impossible is and flood result (NAS 1976). Aquatic plants play a useful role for special purposes. The extents to which aquatic plants are desirable depend on the water user. Eg., a reservoir manager wants clear water that is free of weeds, algae and other organisms. However, conservationists encourage plant cover on watersheds and along the banks of streams, lakes and ponds to control erosion and to protect water quality (Oki, 1994). Plants such as water hyacinth and Salvinia in aquatic environment absorb heavy metals and excess dissolved nitrogen and phosphorus released from fertilizer washed off from farmlands and urban sewage systems, which can cause environmental pollution in the absence of effective sinks. This paper reviews the efficacy of aquatic macrophytes in nutrients and heavy metal sequestering.

USE OF AQUATIC PLANTS AS NUTRIENT SINK

Aquatic vegetation absorbs large amount of nutrients and which is an effective means of stripping nutrients from effluents or natural waters. Boyd (1970) reported that nutrients could possibly be absorbed from effluents by aquatic plants prior to their release into natural water, or plants could be cultivated in lakes and then harvested. A comparative study carried out by Une *et al* (1988) revealed that some plant species grow well in nutrient rich water. N, P and K levels in these species, it was found that the tissue concentration of all these elements was high (Oki *et al* 1989a). Shallow, eutrophic, aquatic ecosystems stocked with macrophytes are among the most productive in the world (Schierup, 1978). The capacity of such systems to decompose organic matter and assimilate nutrient has long been recognized (Brix and Schierup, 1989). It is well known that streams, lakes, coastal areas and wetlands contain a considerable self purification 'self purification' capacity (Seidel ,1976). During the growing season the plants absorb and incorporate the nutrients into their own structures and function as a substrate for microorganism. Brix *et al* 1989 reported that international attention is now tilted towards the ability of aquatic macrophytes to control pollution and also to treat municipal and industrial wastewater. Therefore, macrophytes can be efficient indicators of water quality, and their presence may enhance water quality due to their ability to absorb excessive load of nutrients (Petr, 1987). It has been demonstrated that aquatic weeds such as *Eichhornia crassipes* , *Lemma spp*, *Salvinia, Typha ssp, Phragmites spp* and *Azolla sp* has been utilized as a means of reducing the nutrient levels of polluted water (Oki, 1994).Table 1 shows the removal efficiency of metal ions by some common aquatic macrophytes.

Table 1: Removal efficiency of metal ions by some common aquatic macrophytes

	Metals	Removing efficiency
Eichhornia crassipes	Fe , Cu, Zn , Cd	80.0
Azolla spp	Hg	93.0
Ceratophyllum demersum	Pb, Zn and Cu	80.0
Ipomoea aquatic	Hg	90.0
Lemna spp	Pb	90.0
Ludwigia repens	Hg	99.8
Pistia stratiotes	Cd, Hg and Cr	85 – 90.0
Salvinia herzogii	Cr	70.83

Source: Srivastava,2008

Water Hyacinth

Water hyacinth is a common weed in a eutrophicated water bodies due to its high productivity in the range 106 to 144 tons of dry weight per hectare per year (Reddy and Debusk, 1985; Casabianca, et al 1992).The mean daily production of water hyacinth biomas in tropical areas may be more than 25g m^{-2} day^{-1} of dry matter. Thus more than 0.8 gN and 0.15g P m^{-2} day^{-1} can be removed by harvesting. Similar amount of nitrogen may be removed as a consequence of nitrification, denitrification and volatilisation of ammonia (Brix et al 1989). It has been reported by (Olgiun, et al 1998) that under the climate of Florida, *Eichhornia crassipes* has shown a very high nitrogen (80%) and phosphorus removal (40%). This aquatic plant is suited for nutrient removal systems because it is not rooted and floats on the surface and so can easily be removed by mechanical means and moreover mineral uptake rate per unit dry matter increase are greater in plants in a rapid growth phase (Anonymous, 1969, 1970) in which water hyacinth is one. Water hyacinth is being used in countries such as Brazil as tertiary treatment systems, removing nitrogen and phosphorus. The biomass is harvested frequently to sustain maximum productivity and to remove incorporated nutrients (Mason, 1992).

Water hyacinth can also be used as integrated secondary and tertiary treatment systems, removing BOD and nutrient both decomposition of organic matter and the microbial transformation of nitrogen proceeding simultaneously; in this system harvesting is only carried for maintenance purposes and performance with respect to phosphorus removal is poor (Brix *et al* 1989). Haider *et al* 1981 reported absorption of Pb, Cu, Cd Co Zn, Hg, Cr, Ni, Ca, and Mg from pulp and paper mills by Water hyacinth. The plant has been used in treating palm oil effluents in Malaysia (Abdulahi *et al* 1983). Earlier report of Rachel *et al* (1983) showed the successful utilization of Water hyacinth in the treatment of domestic sewage, nutrient removal from water bodies, sewage and industrial waste. Water hyacinth obtained from Nigerian water bodies contains heavy and toxic metals indicating its high absorbing capacity for these elements (Ogunlade, 1996). NAS (1976) reported that when sewage was passed through a pond at a rate of 2.2 million litres per hectare per day, Water hyacinth growing in the pond removed 80% of the nitrogen compound and 40% of the phosphorus compound in 2 days.

NUTRIENT AND HEAVY METAL REMOVAL BY DUCKWEED

Duckweed can be used for nutrient removal. The dense cover of duckweed on the water surface inhibits both oxygen entering the water by diffusion and the photosynthetic production of oxygen phytoplankton because of poor light concentration. The water consequently becomes anaerobic which in turn favours denitrification. Being relatively thin, the duckweed are readily harvested and used as animal fodder. *Lemma spp* recovers a high percentage of nitrogen from wastewater and may accumulate protein content as high as 40%; it has been used to recover nitrogen and phosphorus from anaerobic effluent from digested pig waste (Hernandez *et al*, 1997). *Lemma spp* has a nitrogen concentration of 200mg/l a fact that may portray this aquatic plant the high potential to treat concentrated effluent such as those that originated from animal production units. *L. minor* has been investigated for the removal of heavy metals from water column (Jain ***et al*** 1990, Wahaab *et al* 1995 and Maine *et al* 2001). *L.minor* can sequester 70-80% of lead in its viable biomass (Sternberg *et al*, 1999). The uptake of metals like Ni, Cd and Zn by different *Lemna* spp. has been reported by Miretzky *et al* (2006).

NUTRIENT AND HEAVY METAL REMOVAL BY *Pistia stratiotes*, *Ipomoea aquatica*; *Salvinia molesta* and *Ceratophyllum demersum*

Pistia stratiotes is reported to reduce the ammonium ions from the water as it utilizes NH_4-N prior to NO_3-N as nitrogen source and does not switch on the utilization of NH_4-N get consumed entirely (Aoi and Hayashi, 1996). *Pistia stratiotes* has been used to remove metals like Zn, Ni, Cd and Zn from water column (Sridhar, 1986).Studies by Miretzky et al 2006 reveal that *P.Stratiotes* biomass were lower as compared to *Spirodella intermedia* and *L. minor* when grown in water containing metals ions of Cd, Ni, Cu, Zn and Pb. Ipomoea aquatica can accumulate higher content of metals such as Fe, Cu,Cr,Cd,Mn,Hg and Pb (Sinha *et al* 1996). It also sequesters organic form methyl-Hg which is a potential toxicant (Boening, 2000). *Salvinia molesta* is well adapted for the removal Cr from wastewater (Maine *et al* 2004). Azolla spp acts as biofilter as it binds heavy metals and is helpful in the purification of waters polluted by Hg and Cr (Bennicelli et al 2004). *Ceratophyllum demersum* is capabe of removing the different chemical species of phosporus (Dierberg et al, 2002). Studies have equally shown that submerged plants are useful in reducing heavy metal concentrations in water, as biomass of their shoot can accumulate large amounts of heavy metals (Rai *et al*, 1995; Jackson, 1998 and Fritioff *et al* 2005. Ceratophyllum demersum act as effective biosorbent for Zn, Pb and Cu metals

under diluted conditions (Keskinkan *et al* 2004). *Ceratophyllum demersum* is used to assess the level of heavy of heavy metal pollution in aquatic bodies (Srivastava, 2008).

CONCLUSION

Nigerian freshwater ecosystem is constantly polluted by inorganic plant nutrients and heavy metals from urban sources derived from domestic and industrial sewages. Aquatic macrophytes are the cornerstones of an aquatic environment. They have the physiological ability of removing mineral nutrients and heavy metals. There is therefore the need to have a detailed study about the use of Aquatic plants for phytoremediation in Nigeria. This is imperative because phytoremediation is less expensive and environmentally friendly alternative in the control of these pollutants.

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