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The Invasive Aquatic Macrophyte, Water Hyacinth {*Eichhornia crassipes* (Mart.) Solm-Laubach: Pontedericeae}: Problems and Prospects

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ABSTRACT

Water hyacinth (*Eichhornia crassipes*) which have been described as the most troublesome weed in the world have been linked to several problems like obstruction to water transportation, micro-habitat for disease vectors, obstruction to fishing and reduction in biodiversity. However, recent studies have also shown that this macrophyte can be used for the production of paper, biogas, fertilizer, fish feed and in the clean-up of polluted environment (phytoremediation). It becomes important to fully harness the potentials of this aquatic macrophyte, which could change its status from a weed to an income-generating plant.

Key words: Water hyacinth, phytoremediation, biogas, fertilizer, animal fodder

INTRODUCTION

The aquatic macrophyte called water hyacinth (*Eichhornia crassipes* [Mart.] Solms) is not new in the ecological history of man. Infect, it has been popularly described as the most troublesome weed of the world (Gopal and Sharma, 1981) because of its rate of multiplication. It is aquatic in nature, deriving its energy form the sun, storing this energy in a semi-succulent stem and a fibrous network of roots (Gopal and Sharma, 1981).

The commonest water hyacinth is the South American species-*Eichhornia crassipes*. It is distinctly divided into three (3) parts; a fleshy leaf (leaves) that form the basis of photosynthetic accumulation, a greenish semi-succulent stem and a rather brownish fibrous root network. The latter is usually submerged under the water and forms the propellant part of the weed (Ndimele, 2008).

As a crop, the weed is still a mystery to many ecologists by virtue of its rapid multiplication. To say that it breeds like a rat is an under-statement, to compare it to the hydra or *Paramecium* could be an exaggeration. However, the weed has a high multiplication factor. *Eichhornia crassipes* has as much as seven-fold (7) increase or spread in 50 days time. Infact, it has been reported that 2 hyacinth plants can grow into 1,200 offspring in 120 days (Gopal and Sharma, 1981).

A possible biological explanation to this behaviour lies in the fact that the plant grows usually in places with high solar energy constants, ranging form 450 to 550 watts per metre square of land. Coupled with this is its high photosynthetic fixation efficiency of 1.52%. When compared to typical crops in sub-saharan Africa like maize, with a value of 1.0%, cocoa with value of 0.5%, elephant grass with a value of 0.48% and groundnut with value of 0.29%, one sees immediately that water hyacinth has a rapid growth tendency (Edewor, 1988).

Cultivation reports from some swampy areas of South America have it that the plant has an annual average productivity of about 350-1,700 tons per hectare of wet vegetation (Gopal and Sharma, 1981). With this high growth rate, waterways are easily clogged up, because “clearing” rate is far below the “multiplication” rate of the plant. This present “menace” position could turn to be a blessing in the near future as possible utilization are sought for the seaweed in the production of animal feeds, detergents and recently in phytoremediation; the deliberate introduction of aquatic weeds like water hyacinth into polluted water bodies so that the seaweed so introduced will absorb pollutants like nitrate, phosphate and heavy metals and thus, purifies the water (Edewor, 1988; Ndimele, 2008, 2010).

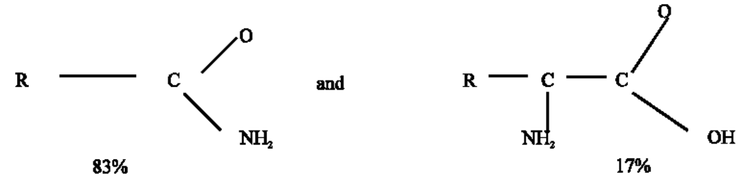
Scientific classification of water hyacinth:

Kingdom	:	Plantae
Division	:	Magnoliphyta
Class	:	Liliopsida
Order	:	Liliales
Family	:	Pontederiaceae
Genus	:	*Eichhornia*

Species:

E. crassipes	:	Common water hyacinth
E. azurea	:	Anchored water hyacinth
E. diversifolia	:	Variable leaf water hyacinth
E. paniculata	:	Brazilian water hyacinth

Elemental composition of water hyacinth: Fresh water hyacinth contains about 90% water and about 15-20% solid materials. On a dry weight basis, the weed contains about 25-35% protein-related matter. Specifically, amino acids constitute about 17% of the total protein matter, the rest being amides. This explains why water hyacinth cannot be eaten fresh like most other edible green vegetables like lettuce (the amides are usually toxic matters). Further analyses show that the carbon content of the dry weed is about 36-40% (Edewor, 1988). Direct carbonylation reactions reveal that the carbonates and nitrates obtained were in the order of 40 to 60% in yield ratios. Thus, water hyacinth has a predominantly cellulosic structure highly impregnated by the amino group directly at the carbonyl structure (Edewor, 1988). The aquatic plant can be conveniently represented as:



where, R could be CH_2 or long chain CH_2-CH_2

Investigations carried out have revealed R to be more of the aliphatic chain. Summarily, therefore, the water hyacinth in elemental composition is about 12.8% nitrogen content, 36-40% carbon, hydrogen about 8% and oxygen about 13-14%. The aquatic plant is also known to be “carrier” of heavy metals like iron, magnesium and zinc, which suggest why it’s being used in photoremediation (Ndimele, 2003; Ndimele and Jimoh, 2010). There are negligible traces of phosphorus and calcium. These metallic ligands can possibly account for the rest of the structure (Edewor, 1988).

Description of water hyacinth: Water hyacinth *(Eichhornia crassipes)* is a member of the pickere/weed family-Pontederiaceae. The plants vary in size from a few centimeters to over a metre in height (Westerdahl and Getsinger, 1988). The glossy green, leathery leaf blades are up to 20 cm long and 5-15 cm wide and are attached to petioles that are often spongy-inflated. Numerous dark, branched, fibrous roots dangle in the water from the underside of the plant. The inflorescence is a loose terminal spike with showy light-blue to violet flowers (Flowers occasionally white). Each flower has 6 bluish-purple petals joined at the base to form a short tube (Westerdahl and Getsinger, 1988). One petal bears a yellow spot. The fruit is a three-celled capsule containing many minute, ribbed seeds.

Geographic distribution: Water hyacinth, "perhaps the world's most troublesome aquatic weed" (Gopal and Sharma, 1981) is a native of tropical South America that has spread to more than 50 countries on five continents and has become a massive problem in waterways in both Africa and Southeast Asia (Barrett, 1989). Its air-filled tissue (aerenchyma) enables it to float and spread rapidly within and between connected water bodies. It reproduces asexually by breaking apart into pieces each of which develops into a separate plant. This results in a rapid increase in biomass and continuous mats of living and decaying water hyacinth up to two metres thick covering the water surface have been reported (Barrett, 1989).

Water hyacinth was introduced to North America in 1884 via the Cotton States Exposition in New Orleans. The plant was displayed in ornamental ponds and distributed as souvenirs to visitors, with the excess dumped into nearby creeks and lakes (Barrett, 1989). The plant soon overtook these lakes and creeks and controlling it became a problem. According to Joyce (1992), these problems led to passage of the River and Harbour act in 1899, authorizing the United States Army Corps of Engineers to maintain navigation channels in these areas. Control efforts included the spraying of sodium arsenite, which poisoned applicators and livestock (Joyce, 1992).

In Nigeria, water hyacinth was first noticed in 1985 in Lagos Lagoon (Edewor, 1988). Since then, it has spread to a lot of water bodies in the country, making navigation and fishing an almost impossible task. Water hyacinth is found in a lot of water bodies in the tropics.

Habitat: Water hyacinths grow over a wide variety of wetland types form lakes, streams, ponds, waterways, ditches and backwater areas. Water hyacinths obtain their nutrients directly from the water and have been used in wastewater treatment facilities (Westerdahl and Getsinger, 1988). They prefer and grow most prolifically in nutrient-enriched waters. New plant populations often form from rooted parent plants and wind movement and current help contribute to their wide distribution (Westerdahl and Getsinger, 1988). Linked plants form dense rafts in the water and mud. In the Pacific Northwest, water hyacinth is planted outdoors in ponds and aquaria, but it is not considered winter hardy, except under special conditions (Westerdahl and Getsinger, 1988).

Reproduction: Water hyacinth (*Eichhornia crassipes* [Mart.] Solms) reproduces sexually by seeds and vegetatively by budding and stolon production. Daughter plants sprout from the stolons and doubling times have been reported by Westerdahl and Getsinger (1988) as 6-18 days. The seeds can germinate in a few days or remain dormant for 15-20 years. They usually sink and remain dormant during periods of stress (droughts). Upon reflooding, the seeds often germinate and renew the growth cycle (Westerdahl and Getsinger, 1988).

Control of water hyacinth: There are three common methods that have been used to control water hyacinth. These are:

- Mechanical control method
- Chemical control method
- Biological control method

Mechanical method: Ever since it colonised the Northern Rivers of New South Wales with such devastating speed, water hyacinth has tested human ingenuity in devising control techniques (Misra and Triphaty, 1975). Early control attempts concentrated on removing the plant from water with hand or instrument like pitchforks, then dumping the accumulated mass on land to die. This control method is costly in time, money and energy and several of the procedures used damaged the ecology, affecting all animal life in the aquatic ecosystem infested by the hyacinth (Misra and Triphaty, 1975).

Chemical method: This method involved the use of herbicides to control water hyacinth. Various kinds of herbicides such as 2, 4-D, Dalapon, Diquat and others have been used in some places (Misra and Triphaty, 1975). They also opined that the ecological problems created by these herbicides were obvious. The water could not be used for irrigation or human consumption for long period of time and the fauna in the ecosystem were seriously affected. Raju and Raddy (1998) working on some herbicides concluded that the best chemical control was achieved with 2, 4-D dimethyl amine 58% (4 kg ha^{-1}). They also reported that the cost of removal by this herbicide was 61% less than that of manual weeding.

Biological method: Biological control of water hyacinth has been studied with several kinds of animals like viruses, bacteria and fungi (Charudattan *et al*., 1978) as well as with Manatees (Allsopp, 1960), insects (Deloach and Cordo, 1976), herbivorous fish such as grass carp and Tilipia, ducks, geese (Ross, 1971; Wilson *et al*., 1977), turtles, snails (Rushing, 1973) and other animals. However, the results were disappointing, perhaps because of defense mechanisms in the plants. For example, the larger plants form 2.5 or more leaves for each one destroyed by pathogen attack (Martyn and Freeman, 1978). Two insects that have enjoyed the widest usage in the biological control of water hyacinth are-*Neochetina eichhorniae*-aweevil and *Neochetina bruchi*-a weevil also. A moth; *Sameodes albiguttalis* have also been used. Jayanth (1988) used *Neochetina eichhorniae* and got an impressive result where 95% of the infestation was cleared within 32 months.

Another method of controlling water hyacinth (*Eichhornia crassipes*) is integration of mechanical, chemical and biological methods because of the inadequacies of each method. Charudattan, (1986) developed a practical integrated water hyacinth control system based on a pathogen, *Cercospora rodmanii*; arthropods, including *Neochetina eichhorniae*; a moth, *Sameodes albiguttalis* and a mite, *Orthogalumna terebrantis* and 2 chemical herbicides; 2, 4-D and diquat. He reported that the pathogen or the arthropods alone did not completely control water hyacinth, but that their combination was highly synergistic, yielding 99% control after 7 months.

The problems caused by water hyacinth infestation: Water hyacinth can cause a variety of problems when its rapid mat-like proliferation covers areas of fresh water. Some of the common problems are listed below:

Hindrance to water transport: Access to harbours and docking areas can be seriously hindered by mats of water hyacinth. Canals and freshwater rivers can become impassable as they become clogged with densely intertwined carpets of the weed. The Ologe Lagoon and the entire Lagos Lagoon complex have been rendered almost impassable by this aquatic plant (Ndimele, 2008).

Clogging of intakes of irrigation, hydropower and water supply systems: Many large hydropower schemes are suffering from the effects of water hyacinth (Center *et al*., 2002). The Owen Falls hydropower scheme at Jinja on Lake Victoria is a victim of the weeds rapid reproductive rates and an increasing amount of time and money has to be invested in clearing the weed to prevent it entering the turbine and causing damage and power interruptions (Mailu, 2001). Water hyacinth is now a major problem in some of the world's major dams-the Kariba dam which straddles the Zambia-Zimbabwe border on the Zambezi River and feeds Harare has pronounced infestations of the weed (Mailu, 2001).

Blockage of canals and rivers causing flooding: If water hyacinth is allowed to grow uncontrolled, it can block canals and rivers, which could lead to flooding.

Micro-habitat for a variety of disease vectors: The diseases associated with the presence of aquatic weeds in tropical developing countries are among those that cause the major public health problems: malaria, schistosomiasis and lymphatic filariasis. Some species of mosquito larvae thrive on the environment created by the presence of aquatic weeds, while the link between schistosomiasis (bilharzia) and aquatic weed presence is well known. Although, the statistical link is not well defined between the presence of aquatic weeds and malaria and schistosomiasis, it can be shown that the brughian type of filariasis (which is responsible for a minor share of lymphatic filariasis in South Asia) is entirely linked to the presence of aquatic weeds (Haider, 1989).

Increased evapotranspiration: Various studies have been carried out to ascertain the relationship between aquatic plants and the rate of evapotranspiration compared with evaporation from an open-surfaced water body. Haider (1989) suggested that the rate of water loss due to evapotranspiration can be as much as 1.8 times that of evaporation from the same surface but free of plants. This has great implications where water is already scarce. It is estimated that the flow of water in the Nile could be reduced by up to one tenth due to increased losses in Lake Victoria from water hyacinth.

Problems related to fishing: Water hyacinth can present many problems for the fisherman. Access to sites becomes difficult when weed infestation is present, loss of fishing equipment often results when nets or lines become tangled in the root systems of the weed and the result of these problems is more often than not, a reduction in catch and subsequent loss of livelihood. Mailu (2001) reported that information from the Fisheries Department, Kenya indicated that there was a 28% increase in total annual fish catches between 1986-1991 and 1991-1997, from 133,097 to 169,890 tonnes. There was an increase in all species of fish caught except *Oreochromis, Clarias* and *Mormyrus,* which showed declines of 14, 37 and 59%, respectively, over the same period. These declines may have been associated with the inability of fishermen to access the fishing grounds for these species because of water hyacinth infestation.

Generally therefore, as a result of water hyacinth infestation, accessibility to land and water has been hindered, resulting in reduced fish catches, especially of tilapia and mudfish which are found mainly along the shores. Fisherfolks, however, reported increased fish catches from suitable breeding grounds provided by water hyacinth e.g., tilapia, synodontis, protopterus and labeo (Mailu, 2001). There is, however, need to clarify this conflicting information; in many more areas around the lake and in other parts of the world. A reduced fish catch would have an adverse effect on the quality of life of the communities around the lake and consequently affect sustainable development in the region.

Reduction of biodiversity: Infestations of water hyacinth affect biodiversity. Dense mats of the weed covering the water surface lead to deoxygenation of the water, thus affecting all aquatic organisms. Death of water hyacinth mats may influence changes in the composition, distribution and diversity of aquatic organisms as follows:

- Displacement of hydrophytes and depressed algal biomass (Twongo *et al.*, 1995; Twongo and Balirwa, 1995)
- Increase in diversity and abundance of some taxa of macrofauna, especially at the borders of the weed mats (Wanda, 1997)
- Increase in the distribution and abundance of schistosome (bilharzia) snail vectors e.g., *Biomphalaria* sp. and *Bulinus* sp.
- Willoughby *et al.* (1993) reported that, based on studies on the Ugandan shoreline of Lake Victoria, mats significantly depressed the diversity of fish species and fish biomass. It was subsequently demonstrated that fish diversity, particularly small taxa, increased along the edge of water hyacinth mats (Twongo and Balirwa, 1995)

Water supply: Water supply to both villages and municipalities is affected by water hyacinth. In municipalities, water hyacinth interferes with the water intake points through blockage, which lowers the quantity of water pumped. In Kisumu, the municipality reports that the quantity of water supplied has dropped from 20,000 to 10,000 m^3 per day (Mailu, 2001).

Water hyacinth infestations have been reported to lower the water quality in Kenya and Uganda (in terms of colour, pH, turbidity (suspended solids) of water) and hence increase the treatment costs. Increased costs are associated with keeping the water intake points free of water hyacinth. For example, Kisumu Municipality employs 12 casuals per day, 6 drivers and 6 boat operators, while Homa Bay municipality engages 2 divers at a cost of 1000 Kenya shillings (Ksh) per day. In Homa Bay municipality, water hyacinth builds up 3 to 4 times in a week and it takes 3-4 h to remove it (Mailu, 2001).

USES OF WATER HYACINTH

Paper: The Mennonite Central Committee of Bangladesh has been experimenting with paper production from water hyacinth for some years (Haider, 1989). They have established two projects that make paper from water hyacinth stems. The water hyacinth fibre alone does not make a particularly good paper but when the fibre is blended with waste paper or jute, the result is good. The pulp is dosed with bleaching powder, calcium carbonate and sodium carbonate before being heated.

The first project is quite large with 120 producers involved in paper manufacture. The equipment for pulping is relatively sophisticated and the end product is of reasonable quality. The second project involves 25-30 people and uses a modified rice mill to produce pulp. The quality of the paper is low and is used for making folders, boxes, etc (Haider, 1989). Similar small-scale cottage industry papermaking projects have been successful in a number of countries, including the Philippines, Indonesia and India (Ndimele, 2008).

Fibre board: Another application of water hyacinth is the production of fibre boards for a variety of end uses. The House and Building Research Institute in Dhaka has carried out experimental work on the production of fibre boards from water hyacinth fibre and other indigenous materials (Haider, 1989). They have developed a locally manufactured production plant for producing fibreboard for general-purpose use and also a bituminised board for use as a low cost roofing material. The chopped water hyacinth stalks are reduced by boiling and then washed and beaten. The pulp is bleached and mixed with waste paper pulp and a filter agent such as china clay and the pH is balanced. The boards are floated in a vat on water and then finished in a hand press and hung to dry. The physical properties of the board are sufficiently good for use on indoor partition walls and ceilings (Haider, 1989).

Yarn and rope: The fibre from the stems of the water hyacinth plant can be used to make rope. The stalk from the plant is shredded lengthways to expose the fibres and then left to dry for several days. The rope making process is similar to that of jute rope. The finished rope is treated with sodium metabisulphite to prevent it from rotting. In Bangladesh, the rope is used by a local furniture manufacturer who winds the rope around a cane frame to produce an elegant finished product (Haider, 1989).

Basket work: In the Philippines, water hyacinth is dried and used to make baskets and matting for domestic use (National Academy of Sciences, 1976). The key to a good product is to ensure that the stalks are properly dried before being used. If the stalks still contain moisture then this can cause the product to rot quite quickly. In India, water hyacinth is also used to produce similar goods for the tourist industry. Traditional basket making and weaving skills are used.

Charcoal briquetting: This is an idea which has been proposed in Kenya to deal with the rapidly expanding carpets of water hyacinth which are evident on many parts of Lake Victoria. The proposal is to develop a suitable technology for the briquetting of charcoal dust from the pyrolysis of water hyacinth. It is suggested that a small-scale water hyacinth charcoal briquetting industry could have several beneficial aspects for the lakeside communities:

- Providing an alternative income
- Providing an alternative source of biomass
- Improvement of the lake shore environment through the removal of water hyacinth
- Improved access to the lake and less risk to maritime transport
- Reduced health risk associated with the presence of water hyacinth
- Alleviation of pressure on other biomass fuel sources, such as wood, thereby reducing deforestation and associated soil erosion

The technical aspects are yet to be fully developed and tested but 7 main stages have been identified in the process of converting the plant into charcoal briquettes:

- Harvesting and collection of the plant
- Drying
- Collection and transport to the kiln
- Pyrolysis
- Mixing of the resultant dust with a binder
- Pressing into briquettes
- Marketing of briquettes

Biogas production: The possibility of converting water hyacinth to biogas has been an area of major interest for many years (Ndimele, 2008). Conversion of other organic matter, usually animal or human waste to biogas is a well established small and medium scale technology in a number of developing countries, notably in China and India. The process is one of anaerobic digestion which takes place in a reactor or digester (an air tight container usually sited below ground) and the usable product is methane gas which can be used as a fuel for cooking, lighting or for powering an engine to provide shaft power. The residue from the digestion process provides an organic fertilizer rich in nutrients.

The use of water hyacinth for digestion in a traditional digester presents some problems. Water hyacinth has very high water content and therefore harvesting effort yields a low reward in terms of organic matter for conversion to biogas. The digester size has to be large compared with that of a traditional type due to the low gas production to plant volume ratio and this can in turn present problems for obtaining an airtight seal. Water hyacinth has to be pre-treated before entering the digester (macerated, chopped or beaten) to promote digestion and to remove air entrapped in the tissue of the plant which would cause it to float. To reduce the need for large volume digesters, high rate digestion techniques have been employed. One such design has been tested in Bangladesh by a team from Warwick University, UK and the Housing and Building Research Institute, Dhaka, Bangladesh (Haider, 1989). The design was for a small (8.3 cm) baffled reactor which was fed with juiced water hyacinth. The throughflow of the reactor was 1.2 cubic metres per day. Some cow dung and rumen (taken from a cow's stomach) was added to the water hyacinth juice to promote digestion. Gas was produced in reasonable quantities but some problems were experienced with throughflow and further development is still required. Other studies have been carried out, primarily in India with quantities of up to 4000 l of gas per tonne of semi dried water hyacinth being produced with a methane content of up to 64% (Gopal, 1987). Most of the experiments have used a mixture of animal waste and water hyacinth. There is still no firm consensus on the design of an appropriate water hyacinth biogas digester.

Water purification: Water hyacinth can be used to aid the process of water purification either for drinking water or for liquid effluent from sewage systems. In a drinking water treatment plant, water hyacinth has been used as part of the pretreatment purification step. Clean, healthy plants have been incorporated into water clarifiers and help with the removal of small flocs that remain after initial coagulation and floc removal or settling (Haider, 1989). The result is a significant decrease in turbidity due to the removal of flocs and also slight reduction in organic matter in the water.

In sewage systems, the root structures of water hyacinth (and other aquatic plants) provide a suitable environment for aerobic bacteria to function. Aerobic bacteria feed on nutrients and produce inorganic compounds which in turn provide food for the plants. The plants grow quickly and can be harvested to provide rich and valuable compost. Water hyacinth has also been used for the removal or reduction of nutrients, heavy metals, organic compounds and pathogens from water (Gopal, 1987).

Animal fodder: Studies have shown that the nutrients in water hyacinth are available to ruminants. In Southeast Asia, some non-ruminant animals are fed rations containing water hyacinth. In China, pig farmers boil chopped water hyacinth with vegetable waste, rice bran, copra cake and salt to make a suitable feed. In Malaysia, fresh water hyacinth is cooked with rice bran and fishmeal and mixed with copra meal as feed for pigs, ducks and pond fish. Similar practices are much used in Indonesia, the Philippines and Thailand (National Academy of Sciences, 1976). The high water and mineral content mean that it is not suited to all animals. The use of water hyacinth for animal feed in developing countries could help solve some of the nutritional problems that exist in these countries. Animal feed is often in short supply and although humans cannot eat water hyacinth directly, they can feed it to cattle and other animals which can convert the nutrient into useful food products for human consumption.

Fertilisers: Water hyacinth can be used on the land either as a green manure or as compost. As a green manure, it can be either ploughed into the ground or used as mulch. The plant is ideal for composting. After removing the plant from the water, it can be left to dry for a few days before being mixed with ash, soil and some animal manure. Microbial decomposition breaks down the fats, lipids, proteins, sugars and starches. The mixture can be left in piles to compost, the warmer climate of tropical countries accelerating the process and produces rich pathogen-free compost which can be applied directly to the soil (Palprasert *et al.*, 1994). The compost increases soil fertility and crop yield and generally improves the quality of the soil. Compost can be made on a large or small scale and is well suited to labour intensive, low capital production (Palprasert *et al.*, 1994). In developing countries where inorganic fertilizer is expensive, it is an elegant solution to the problem of water hyacinth proliferation and also poor soil quality. In Sri Lanka, water hyacinth is mixed with organic municipal waste, ash and soil, composted and sold to local farmers and market gardeners.

Fish feed: The Chinese grass carp is a fast growing fish which eats aquatic plants. It grows at a tremendous rate and reaches sizes of up to 32 kg (National Academy of Sciences, 1976). It is an edible fish with a tasty white meat. It will eat submerged or floating plants and also bank grasses. The fish can be used for weed control and will eat up to 18-40% of its own body weight in a single day (Gopal, 1987). Other fish such as the tilapia, silver carp and the silver dollar fish are all aquatic and can be used to control aquatic weeds. The manatee or sea cow has also been suggested as another herbivore which could be used for aquatic weed control. Water hyacinth has also been used indirectly to feed fish. Dehydrated water hyacinth has been added to the diet of channel catfish fingerlings to increase their growth (Gopal, 1987). It has also been noted that decay of water hyacinth after chemical control releases nutrients which promote the growth of phytoplankton with subsequent increases in fish yield (Gopal, 1987).

Phytoremediation of heavy metals and crude oil-polluted site: Several authors (Ndimele, 2003; Kumolu-Johnson *et al.*, 2010; Ndimele and Jimoh, 2010) have reported on the ability of water hyacinth to absorb heavy metals and rid the aquatic environment of these pollutants. The results are quite encouraging. As a matter of fact, Ndimele and Jimoh (2010) reported on passive phytoremediation of heavy metal in Ologe Lagoon, Lagos, Nigeria by water hyacinth. They reported that water hyacinth that was not deliberately introduced into the lagoon to absorb heavy metals did so even when the concentration of the heavy metals in the water column was very small. However, the study on phytoremediation of petroleum hydrocarbon by water hyacinth is still at the infancy. Few studies (Ndimele, 2008; Ndimele, 2010; Ndimele *et al*., 2010) have been done on it which indicates that water hyacinth can absorb crude oil but more still needs to be done to fully establish the efficacy of water hyacinth in phytoremediation of petroleum hydrocarbon.

CONCLUSION

Although, water hyacinth have been described as the most troublesome weed in the world because of its rate of multiplication. It has also been partly responsible for dwindling fish catch, loss in biodiversity, clogging of canal, which could cause flooding and navigational problems. However, it has some uses: it can be used in the production of paper, fish feed, biogas, fertilizer and recently, it was found to be able to absorb pollutants like heavy metals and petroleum hydrocarbons in a process called phytoremediation. If properly harnessed, its prolific rate of multiplication, which is presently seen as a disadvantage, can be turned into an advantage.

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