A REVIEW OF THE UTILISATION OF WATER HYACINTH: ALTERNATIVE AND SUSTAINABLE CONTROL MEASURES FOR A NOXIOUS WEED

M. OJEIFO*, P.A. EKOKOTU**, N.F. OLELE**
and J. K. EKELEMU**

*Department of Agronomy, Forestry and Wildlife,
Delta State University, Asaba Campus, Asaba.

**Department of Animal Science and Fisheries,
Delta State University, Asaba Campus, Asaba.

ABSTRACT

The global concern on the problem of the infestation of water bodies by water hyacinth (*Eichhornia crassipes*) has provided the impetus for researchers and other concerned bodies to exploit ways of controlling its spread. Generally, efforts in this regard have been directed at the complete elimination of this weed from our water bodies. It is believed that water hyacinth is potentially beneficial to man, hence, this review was undertaken to highlight its possible application in aqua-culture, bio-gas production, livestock feed, bio-fertilizer, waste water treatment and as raw material for industries. It is suggested that cottage industries be established in the affected communities to translate these possibilities into income earning sources. Thus, with institutional support from government and non-governmental organisations, the water hyacinth menace could be transformed from nuisance to wealth generation, employment and poverty alleviation.

INTRODUCTION

In the tropics, aquatic weeds, especially water hyacinth (*Eichhornia crassipes*), affect man and his well-being by impeding water flow in irrigation and drainage canals, altering the oxygen level of the water, thereby affecting fish and the quality of water for domestic and commercial use. They also hinder or completely prevent navigation of river systems, encourage the build-up of snails, which are essential intermediate host for bilharzia organisms and liver-flukes, and provide or enhance breeding places for certain disease-carrying mosquitoes (Bennett and Woodford, 1978).

In spite of these problems, a critical study of the plant physiology indicated that it could have potential application in agriculture and in homes. There must be a concerted effort therefore, at harnessing this beneficial biological resource rather than just spending huge financial and human resources at just eradicating it.

The 'beautiful blue devil' water hyacinth, recognizable by its lavender flowers and shinning bright leaves is a prolific aquatic plant, which spreads at an alarming rate. The weed has adapted itself exceedingly well to almost every area in which it has been introduced. It has an extremely high growth rate, propagates itself vegetatively and sexually. Its rapid proliferation often results in the clogging of drains and can interfere with shipping, recreational activities and the movement of water. Tyagarajan (1983a) reported that one hectare pond of water hyacinth will produce 0.9 to 1.8t of dry matter per day. It grows rapidly in water with temperatures of between 28 and 30°C and with a pH of 4.0 - 8.0, and ceases to grow when the water temperature is above 30°C or below 10°C. The weed dies when the tip rhizome is frozen.

The weights and proportions of water hyacinth differ considerably in different samples collected in various seasons. However, the typical green plant consists of 24.8 percent root, 41.9 percent stalk, and 33.3 percent leaf (Thyagarajan, 1983). Only the stalk portion of the plant is used for the manufacture of paper-board.

ORIGIN AND DISTRIBUTION

Eichhornia crassipes is one of the world's major free-floating aquatic macrophytes with long hanging roots in water. Early records of its presence in River Nile was in the later part of the 18th Century (Garry, *et al*, 1997). The plant now circum-globed in tropical and sub-tropical regions, was first noticed in Nigerian waters, on the shore of Lagos lagoon in October 1984 (Ekelemu 1998), but has since spread to other parts of the country, particularly in the Coastal states.

Coupled with the near stable nature of the tropical environment, the plant is euryhaline, tolerating both fresh and marine waters, hence its spread knows no boundaries. Further to this, man through his activities such as discharge of waste-water, industrial effluents, run-off from land into the water systems, has greatly altered the hydrological regime of the waters thereby increasing the nutritive level of the aquatic environment which favours the growth and spread of the plant.

APPLICATION IN AQUACULTURE

A common observation in recent times in Nigeria is the practice whereby fish farmers allow controlled growth of water hyacinth in their fish ponds. Evidently, such plant is employed to provide shade against the scorching effects of sunlight during the day, as well as offering protection for the young fish against predators. Similarly, water hyacinth is used as a substrate for the deposition of eggs by spawning brood-stocks especially for the production of ornamental fish. Scores of water hyacinth are introduced into the spawning ponds especially for the production of ornamental fish. Thereafter, the brood fish are put into the pond. After spawning, the water hyacinth is removed with the eggs adhering to the roots. The whole plants with the eggs are incubated in the hatchery. After hatching, the hatchlings detach from the root system of the weed and swim freely. At this stage, the weed is removed from the ponds.

APPLICATION IN BIOLOGICAL WASTE WATER TREATMENT

The application of water hyacinth for waste water treatment in Nigeria, is gradually gaining ground. Ogunlade (1992) reported its potentials as a mopping agent and scavenger of heavy and toxic

elements in industrial and domestic effluents. Akobundu (1987) reported the use of water hyacinth for waste water treatment by some agencies. The capacity of this plant to purify water rests on its ability to vigorously extract nutrients from its medium. Laboratory analysis has shown that water hyacinth is of a high absorptive capacity (Soerjani, 1984). Although it is relatively poorer in extraction of nutrient compounds when compared to water lettuce and guinea grass (Table 1), it functions as an effective mopping agent and scavenger of heavy metals like cadmium, mercury, and nickel. And also its extraction of other chemical substances such as nitrates, phosphates, ammonia, silicate, chlorine and sulphur deposited in the aquatic habitat from industrial and domestic effluent is remarkable (Ogunlade, 1992). Its vigorous growth and repeated cultivation coupled with its capacity to extract nutrients efficiently from its medium makes it a good candidate for the purification of turbid and polluted waters. However, it should be curtailed to prevent dispersal beyond the area of application.

A RAW MATERIAL FOR BIO-GAS

Bio-gas technology requires large amount and continuous supply of vegetative materials for the production of methane which can be used directly in homes for cooking and heating and even in agriculture for drying or converted to other sources of energy, such as electricity. The menace of aquatic weeds such as *E. crassipes* could be converted to an economic resource for the welfare of man. This process will go a long way in ameliorating the threat posed by the incursion of water hyacinth into our water bodies.

Table 1. Analysis Of Water Hyacinth, Water Lettuce And Guinea Grass For Eight Different Minerals

	Sample		
Mineral Concentration (ppm)	Water hyacinth	Water lettuce	Guinea grass
Calcium (Ca)	1,808	6,594	4,545
Phosphorus (P)	791	1,108	3,030
Potassium (K)	46,060	72,524	2,257
Magnesium (Mg)	3,114	3,305	2,952
Sodium (Na)	3,784	2,043	174
Manganese (Mn)	222	156	212
Iron (Fe)	2,557	6,717	213
Copper (Cu)	20	31	26

Source: Aderibigbe and Brown (1993)

The utilization of water hyacinth through bio-gas production is a household slogan in Porto-Novo, Benin Republic. This activity is a sustainable alternative which is the most cost-effective endeavour of tremendous benefit in all communities where this weed abounds (Tobor, 1994). Biogas production is most appropriately termed Biomethanogenesis (National Academy of Sciences 1987). This term was given birth to due to the high amount of methane (40 – 65%) produced during the digestion process.

For the production of this gas on a small scale, Soerjani (1984) has suggested that a digester of 6 in^3 in dimension be loaded with a mixture of shredded water hyacinth (stems) and 10% by weight of cattle dung. The temperature of 30 – 35°C at pH of 7.0 – 7.5 is maintained for maximum production. This set-up is left for one week before the production of gas commences and continues for the next four weeks. Approximately, 2.0m^3/day of the gas produced was used on a burner for 3 hours or in a gas lamp for 6 hours. Pig dung produced 7.0m^3 while poultry dung yielded 29.4m^3. It has been recommended that ferro-cement gives a better yields of this gas and should be used. However, other types of digesters include French, Chinese, Indian and Trans-mulched.

AS RAW MATERIAL FOR BIO-FERTILIZER

Bio-fertilizer is acclaimed to be a sustainable source of plant nutrient due to its improvement of soil structure as well as the slow release of the nutrients. The biomass of water hyacinth can be used directly as green manure as compost. Also, the digested vegetative waste from biogas generation as indicated above can also be collected for use directly on the farm. Alternatively, these materials could be mixed with other organic materials before use.

The practice is popular among farmers around the aquatic habitats where water hyacinth abounds. The waste products (slurry) coming from biogas production is collected regularly and used for growing maize, peanuts, soybean and cassava.

The coarse powder obtained from the root of water hyacinth has effectively been used to aid crop production in economic crops such as vegetables (Chakraverty, 1983; Oso, 1988). Because of the high moisture content of this plant, it was reported to increase the moisture holding capacity of the soil while promoting good adhesion to seeds. In whatever condition, water hyacinth is used, it may be necessary to do mineral analysis to guard against the pollution by potential uptake of heavy metals.

AS RAW MATERIAL FOR LOCAL INDUSTRIES

Akobundu (1987) reported that aquatic weed, can serve as raw material for pulp and paper, fibre for making chairs, mats and baskets. It can also be used as thatch. However, their application has not received the required attention. Healey (1994) observed that the enormous biomass of water hyacinth has stimulated many attempts at its utilization. He further reported that it has limited application in the manufacture of poor quality paper,

biogas generation, effluent treatment and certain handicraft. Research could improve on the existing information at converting the raw material of water hyacinth into industrial products. This feed the industries. The whole process could generate employment and alleviate poverty in the affected areas.

Thyagaraja (1983) demonstrated how the stalks of water hyacinth could be pulped, and converted into medium quality papers/boards such as cardboard and coloured cards/cover papers. Such pulps should however be blended with long fibrous pulps such as cotton rags and waste paper pulps to minimize the shrinkage of paper during drying. However, the manufacture of bond and other high quality paper is not economically viable owing to the low yields of water hyacinth pulp. Even for the manufacture of medium quality paper/boards Thyagaraja (1983) advised that the manufacturing unit should be attempted and this will go a long way in stimulating community participation by reducing the nuisance created by water hyacinth, when continuous harvest is made and manufacturing units located in all places where water hyacinth is available in abundance and free of cost.

POTENTIALS AS A FEEDSTUFF

The dearth of animal protein with increasing cost of food production coupled with rapid population growth necessitate the search for non-conventional sources of protein such as leaf protein concentrate (LPC) from water hyacinth (Ogunlade *et al* 1988). The plant in combination with concentrate of other feeds has proved to be a good quality protein source for animal feed (Igbinosun and Talabi, 1982).

When compared with conventional NIOMR feeds, dried water hyacinth was found to be a suitable artificial feeds for the culture of tilapia (Tables 2 and 3).

Table 2. Proximate composition (%) of NIOMR fish feed and dried water hyacinth.

Components	NIOMR Feed	Water Hyacinth
Crude Protein	38.5	14.2
Crude Fibre	9.0	20.4
Crude Fat	-	3.3
Lipids	6.8	-
Moisture	13.4	10.4
Others	32.3	-
Ash	-	27.2
N-Free extract	-	24.6

Source: Igbinosun and Talabi (1982).

Table 3: Growth Increase (%) Of Tilapia Fed With NIOMR Feed And Water Hyacinth (Based On Table 2) Over Eight Week Period

	NIOMR feed	Dried water hyacinth
Weight increase	49.5	22.2
Length increase	15.4	5.5
Food Conversion ratios	6.61	12.90

Source: Kusemiju and Akingboju (1998)

Some other documented research findings have indicated that water hyacinth has great potentials as animal feed source (Tables 3 and 4). It has a reasonable amount of crude protein content, and compares more favourably with guinea grass that has enjoyed widespread use as silage to feed livestock.

Pig can consume 1-2kg fresh weight of Water hyacinth daily. The dried, crushed ones are used in mixtures of various percentages, 2.5 – 10% with the ordinary feed for pig, chicken, ducks, cow and rabbits (Soerjani, 1984). This has limited scope in the present practice and the quantity potentially utilized is not substantial enough to meet the control target.

Aderibigbe and Brown (1993) have demonstrated that the nutritive value as well as nutrient digestibility of water hyacinth is enhanced when dried and supplemented with high energy feed ingredient and a suitable protein source (Table 5). Thus, water hyacinth though now a foe, is a potential saviour of the animal feed industry that is currently groaning under high cost of feedstuff.

TABLE 4: Composition of water hyacinth and guinea grass

	Water hyacinth	Guinea grass
Dry matter (DM.%)	10.2	33.1
Gross energy (Kcal/g of DM)	2.2	3.5
Analysis of DM (%)		
Organic matter (OM)	57.0	89.4
Crude Protein (CP)	11.3	6.7
Crude Fibre (CF)	11.7	30.2
Ether Extract (EE)	3.4	4.4
Ash	43.0	10.6
Nitrogen Free Extract	30.6	48.1

Source: Aderibigbe and Brown (1993).

Table 5: Crude Protein (%) of Water Hyacinth and Guinea Grass Silage Supplemented With Different Nitrogen Sources and Various Levels of Maize

Level of Maize	Water hyacinth		Guinea grass	
	Groundnut cake	Blood meal	Groundnut cake	Blood meal
0	18.3	18.1	14.6	14.9
10	18.9	18.8	16.4	15.1
20	18.5	17.0	14.1	15.1
% Digestibility	45.3	58.4	41.4	25.9

Source: (Aderibigbe and Brown, 1993)

CONCLUSION

The threat of water hyacinth to aquatic ecosystems is real. The infestation of our water bodies by this aquatic weed is a scourge that must be tackled with all amount of seriousness. However, the current drive towards the total eradication of the weed may not be the most viable option, for the reason of high cost and the fact that some of the eradication methods may do further harm to the environment.

In the face of today's economic stress militating against mankind, the costs of basic input resources have gone beyond the reach of ordinary people. Water hyacinth, which is seen as a nuisance and combated at huge economic costs to resource-poor economies, may well become the cornerstone of raw-material production to the growing industries. The potentials outlined have good promises particularly for a growing economy. The international efforts to rid the water bodies of water hyacinth deserves commendation but the need to turn its menace into a blessing for the populace, in our opinion, will certainly receive a wider support.

Thus, the exploitation of means by which this plant could be harnessed and put into profitable use may sound a viable option. Some of these probable benefits have been articulated and advocated. However, the realization of these objectives may truly be possible if there is institutional support from the government and non-governmental organisations (NGO's) in the form of establishment of pilot programmes or cottage industries to translate some of these potential benefits into income generating ventures. Additional institutional support could also be in the form of research grants, public enlightenment of local communities, extension services, on existing technology on the utilization of water hyacinth, and capacity building for potential operators of the industry. This could create employment, and alleviate poverty.

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