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Water Hyacinth-Creation of Healthy Wealth from Menace

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Abstract

Water pollution is the major part of concern in today's world, pollution due to aquatic weed is one of the serious aspects in this context. In the list of major polluting aquatic weed, water hyacinth is in the top, it is an exotic weed. The common water hyacinth (Eichhornia crassipes) is a vigorously growing weed. Mainly people seen its one phase which is related to pollutant only, but on the other hand it is all in one plant. It can act as a phyto-remediator to control the contaminant from the water or the sewage plants as well as it can be transformed into a source of income for communities. Stems can be turned into furniture and paper, use in textile industries and handcraft making or used to create fertilizers. It also uses as a natural wastewater purifier and an indicator of the level of pollution in the water bodies. Phytoremediation is an efficient and economical method of contaminant removal without further damaging the environment. Once removed, the metals can be re-extracted for proper disposal or possibly for reuse. The reviewed experiments revealed that there was a reduction of 80% in COD and about 25–45% reduction in metals after 18 days period. In studies the water hyacinth removed approximately 65% of lead, 50% of cadmium and 65% of mercury from water polluted with 10 ppm of lead and 1 ppm of mercury and cadmium respectively. One hectare of water hyacinth plants is potentially capable of removing 160 kg of phenol per 72 hectares from polluted water. Combination of microorganism with water hyacinths must be seriously considered in developing filtration system for removing heavy metals and carcinogenic materials.

Key words: *Water hyacinth, Handloom, Phytoremediation, textile, environment, and Manure.*

Introduction

Description of Water Hyacinth

Water hyacinth is widely recognized as the world's worst aquatic weed. Originally exported from its native Amazonia because of its attractive flowers, the species rapidly established and spread throughout tropical, subtropical and warm temperate regions of the world. Water hyacinth forms a dense impenetrable mat across the water surface, limiting access by man, animals and machinery. Navigation and fishing are obstructed, and also affect the irrigation and drainage channel. The consequences are devastating for those communities reliant on water bodies for water, food, sanitation and transport. Programs to control its growth have been initiated in most countries where it occurs. Water hyacinth, *Eichhornia crassipes*, is a perennial, herbaceous, aquatic plant of the family Pontederiaceae. The genus *Eichhornia* contains a number of other species, all aquatic, but only *E. crassipes* has become a serious weed. The leaves of water hyacinth are comprised of a smooth, glossy, circular to kidney-shaped lamina

and a thick, spongy, aerenchyma-filled petiole. The large air spaces within the petioles allow the plants to float on the water surface. Water hyacinth floats while all other members of the family Pontederiaceae are rooted in the substrate. Stolons grow horizontally outwards from terminal buds at the base of mature plants, sown in fig 1.1. A daughter plant, or ramet, develops at the end of each stolon. The bisexual flowers are bluish purple with a yellow center and are produced on single spikes to 60 cm in length emanating from several centimeters below the petiole/lamina junction. The flowers can self-fertilize. The roots are long, fibrous and feather-like, and are often dark in colour. Flowers are of three distinct types, differing in the relative length of styles within single flowers. Vegetative reproduction is a common form of propagation and is largely responsible for the rapid increase and spread of water hyacinth into new areas. The daughter plants produced from the horizontal stolon develop roots and eventually separate from the mother plant following decay or breakage of the connecting stolon.

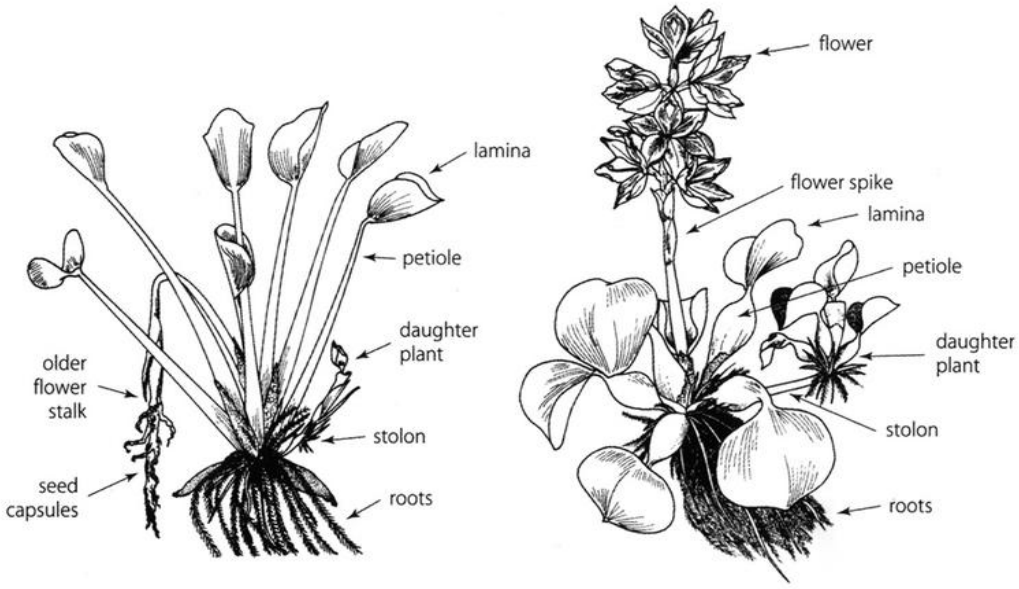

Fig 1.1- Morphological Description of Water Hyacinth- Book of Weed Management by – (Gopal and Sharma, 1981),

Distribution and habitat of water hyacinth

The centre of origin of water hyacinth is believed to be Amazonia, Brazil, with natural spread throughout Brazil and to other Central and South American countries. The spread of water hyacinth to new areas commenced in the 1880s with its deliberate introduction into the United States of America (USA) as an attractive pond ornamental. Live plants were supposedly handed out to visitors at the 1884 New Orleans Cotton Expo. Thereafter, plants continued to be spread around the USA and eventually around the world. Many of these plants were disposed of or spread into ponds and waterways where they rapidly established and continued to expand their range. The spread of water hyacinth has been spectacular and disastrous. The weed was recorded in Egypt, Australia and southern Asia (India) by the 1890s, China and the Pacific by the early 1900s, East Africa by the 1930s, West Africa by the 1970s and is now established throughout tropical and

warm temperate regions of the world from 40°N.

Optimum growth of water hyacinth occurs in eutrophic, still or slow-moving fresh water with a pH of 7, a temperature range between 28°C and 30°C, and abundant nitrogen, phosphorus and potassium. Although prolonged cold weather may kill plants, the seeds remain viable. Plants can infest pristine, relatively low nutrient waterways and can survive for several months in low-moisture substrates. They can tolerate acidic waters but cannot survive in salt or brackish water.

Disadvantages of water hyacinth

The water bodies which are worst affected are still or slow-moving, and include natural water courses, natural and artificial lakes, irrigation and flood mitigation channels, and dams. Navigation is obstructed and irrigation systems become blocked. The weed may provide suitable breeding sites for vectors of human and animal diseases, increasing the incidence of diseases such as malaria, encephalitis, schistosomiasis, filariasis, river blindness and possibly cholera[6]. The presence of water hyacinth has a direct impact on the hydrological balance of a system. This can dramatically increase the rate of water loss from a water body, imposing higher operational costs on water supply schemes. Extensive mats of water hyacinth also change the physical and chemical composition of the water beneath. Light penetration is reduced and oxygen levels decline, resulting in anaerobic conditions. This leads to biological changes in the water body that are unfavorable to communities of aquatic vertebrates, invertebrates and plants.

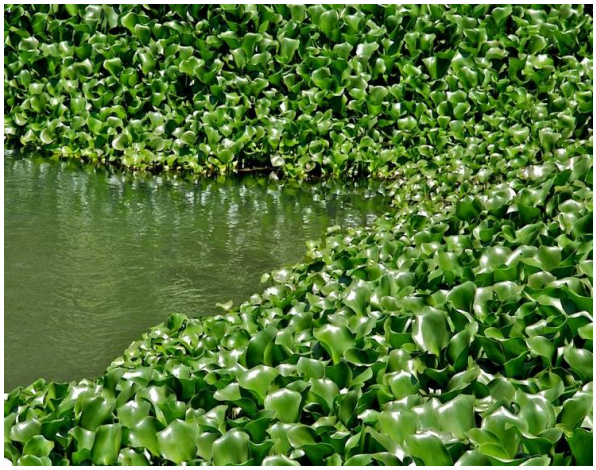

Figure 1.3 - **Part of River Yamuna covered with lush green water hyacinth, Delhi, India – recently clicked figures - 22-6-2017**

Precious role of jalkumbi

Water hyacinth is an exotic weed, also called “Terror of Bengal”. Other than its menace it will soon know as the “Wholesome Plant”. In Bangladesh it is used in textiles industries, fashion world and paper industries[7], it is also used in the ruminant feeding in piggery, used in biogas production and water hyacinth manure (WHM), also used in Phytoremediation and sewage water treatment due to its detoxification property, reducing the BOD of sewage water and trim down the heavy metal from the water source[8]. At last for the rural community, the way to generate the income or wealth from menace is to use

the water hyacinth and its extract for handloom production. It is the natural gifted plant, by the proper management and judicious use of which we can earn income as well as manage the environmental pollutions[2].

Water Hyacinth as A Feeding Source For The Ruminant

Water hyacinth (Eichhornia crassipes)an abundantly available aquatic plant of this region considered menace and the age old tradition believe that if this plan is fed to animal it will affect the health of the animals with severe diarrhea and suffer from salt imbalances[1]. Water hyacinth is good feeding source in piggery which is depicted in fig 2.1. There are two types of water hyacinth available in the region - 1) Long type 2) Dwarf type. The former type is mostly available in stagnant water having high effluent while the latter is available mostly in the paddy field. Water hyacinth is good feeding source in animal husbandry. Biomass yield (ton/ha/year) of water hyacinth was estimated at 322.2 tons (approx. 30.45 tons DM/ha/year at 9%-10% DM content). The whole plant showed significantly ($P<0.001$) lower DM digestibility (42.32%) compared to leaves and shoots (58.15 and 57.03%). Water hyacinth either fresh or wilted forms is not very much liked by animals, however, water hyacinth silage (4 part W H.: 1 parts paddy straw with 5% molasses on DM basis) the consumption is significantly more. Feeding of water hyacinth silage and para hay (50:50) with concentrate showed best performance in daily milk yield. Water hyacinth is widely used in pig and donkey feeding in the Far East. This suggests that its digestibility is not a limiting factor and that when used in ruminants the high protein content could be of benefit even for the young or lactating ruminants. This characteristic could make water hyacinth a potential source of fertilizer both in its fresh form and when voided by livestock as manure. The results of mineral analysis indicated that the calcium content of naturally dried water hyacinth was more than of fresh one, while phosphorus content was just the reverse.

Fig 2.1 - Water hyacinth as a source of feeding in piggery- Potential of water hyacinth *(Eicchornia crassipes)* in ruminant nutrition in Tanzania- **(**Aboud *et.al*., 2013)

WATER HYACINTH USE IN TEXTILES, FIBERS AND FASHION TECHNOLOGY

According to an article on "Use of Water Hyacinth in Sustainable Fashion" by *Md. Rashedul Alam-BGMEA Institute of Fashion & Technology* (2009). Researchers are always looking for new fiber sources and improved methods of sustainable processing. The goal being to provide an all-natural and preferably organic fibrous material that can be used in the textile industry for the use in garments, interior decorating and upholstered goods. Water hyacinth fabric is not available on the market yet, but it will be the futuristic concept of new fiber in textiles industries and new revolution in fashion world. The stalks went through a series of chemical and mechanical treatment to achieve the crimp property of wool for better processing, reduce the plant's glue-like or gum content, and soften the fibers to make them fine and fit for knitting and weaving into apparel and other home textiles. We are having the live practical example in Bangladesh. Fig 3.1 shows the role of water hyacinth in fashion industries and textiles industries. Bangladesh has given the Bangladeshi weavers and artisans a golden opportunity to utilize their considerable skills and talents to achieve economic survival and to build towards a prosperous future & promoting Bangladeshi fabrics and handicrafts for domestic and international markets under the slogans *"Fashion for Development and Positive Bangladesh"*.

Fig 3.1- shows the use of water hyacinth fiber as a textile and fashion industries. Use of Water Hyacinth in Sustainable Fashion *Md. Rashedul Alam- BGMEA Institute of Fashion & Technology from TTH 2009 article*

WATER HYACINTH USE IN HANDLOOM MANUFACTURING – RURAL INCOME SOURCE

4.1 Manufacturing Process for Water Hyacinth into Fiber for Handicrafts

Recover: The stem should be at least 50 cm long and mature, as young stems produce brittle or soft fiber. *Split*: The stem is then split lengthwise. Each slice should be at least 2.5 cm in cross-section. The pith, soft plant tissue that surrounds the hollow stem, is removed by rubbing after one day of sun drying. Do not dry the strands for more than three days or they will become brittle. *Dry and dye:* The cut,

split stems are air-dried for 4 to 6 more hours in the direct sun until stems are dry but pliable. Further drying is necessary if only colored ropes are required. *Treat and sort:* Treat dried stems & Prepare 250 g of sodium meta-bisulphate in 10 liters of water. Soak 5 kg of stems by submerging for 1 hour. Rinse the stems in room-temperature water and air dry for 1 day. Sort stems by length and cross-section so that rope and braid is more uniform. *Twist or braid:* Fiber may be either twisted or braided into ropes of different thickness depending on the crafts to be made. Before braiding, sort the strips into various lengths and thickness. For rope, twist two pieces of stem fiber into one by rolling. For braid, pass three pieces over-and-through to produce a single braided length. *Join:* Toward the end of each stem segment, the fiber tapers. Combine additional tapered ends by joining additional twisted or braided segments until the desired length is achieved. As the fiber is processed, it is rolled into loops or spools.. In case of more coarse, the rope making process is similar to that of jute rope. The finished rope is treated with sodium metabisulphite to prevent it from rotting.

Market value

In Bangladesh, the rope is used by a local furniture manufacturer who tired the rope around a cane frame to produce an elegant finished product. Fig 4.1 shows the flow chart representation for the hyacinth extraction and handloom manufacturing. The innovative craft developed and introduced by the North Eastern Development Finance Corporation Ltd (NEDFi) has helped improve the socio-economic status of the rural poor, enabling them to make eco-friendly products out of this water-weed and providing a new genre of artisans the required sustainable market support. This unique eco-friendly project of NEDFi has proved to be a success story - it has transformed the lives of the rural poor and at the same time turned the water hyacinth from being merely a wild water-weed to 'pearl of water' since 2008.

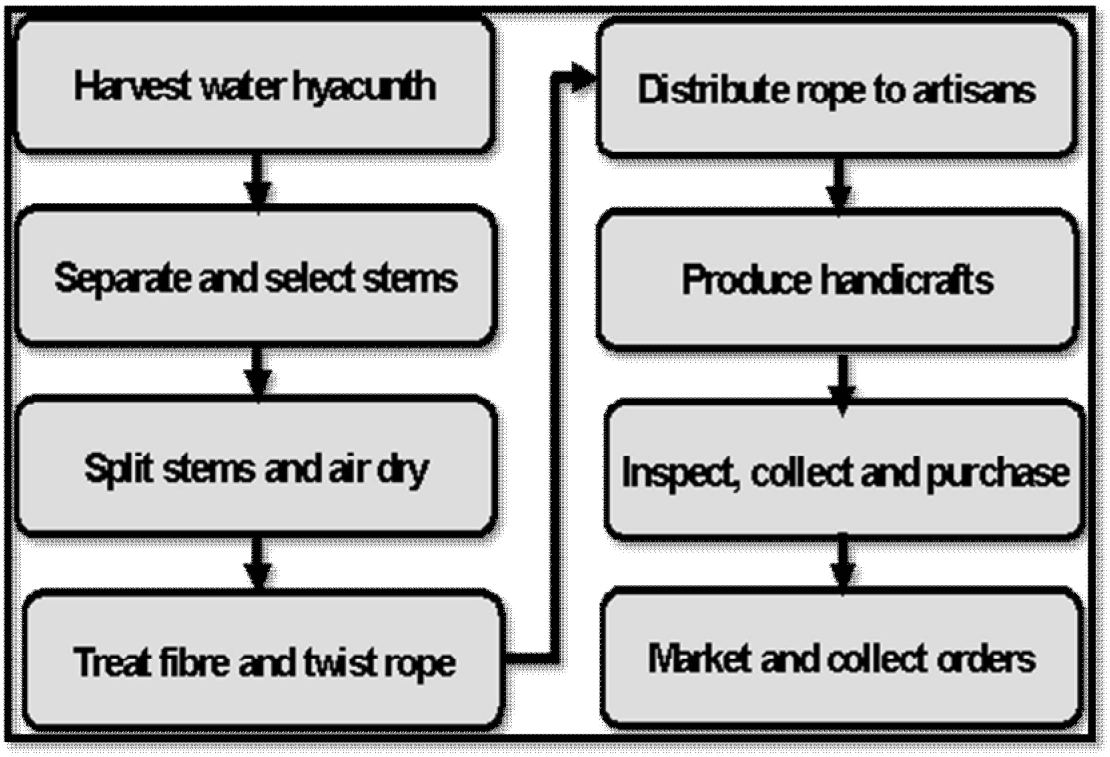

Fig 4.1 shows the processing of water hyacinth for fiber extraction and the furniture or crafts made from water hyacinth.

WATER HYACINTH AS A SOURCE OF GREEN AND ORGANIC MANURES (WHM)

5.1- Case study in crops:

Efforts at remediating soil fertility over the years have basically been achieved using traditional resources of farmyard manure and crop residues in composted forms as well as use of inorganic fertilizer. Weed however; have been recognized to have significant effects on sustainability of soil nutrient resources and yield of agricultural produce. The study of water hyacinth as biofertilizer revealed that the incorporation of water hyacinth into soil crop system increased the performance yield of the crop plant *Brassica juncea.* Water hyacinth manure (WHM) in all combinations was found to be more effective for the growth and yield of the test plant over the control. Previous study have reported enhancement in yield/plant in rice, corn, sesame, brinjal, onion and gourd, using water hyacinth compost. Soil fertility potential of water hyacinth compost and revealed its enhanced affect on productivity of *Zea mays* crop. These results, it can be suggested that, by the addition of water hyacinth manure into cultivation which affected the performance of test plant may be probably due to the increase of Nitrogen availability released from water hyacinth during the process of mineralization[4, 5]. This is in agreement with Contantinides & Fownes who mentioned that quality and quantity of added organic materials into soil may influence the decomposition rate and mineralization process. WHM water hyacinth manure is a good source for the organic farming and its leads to reduce the other chemical use by promoting sustainable agriculture[9]. In **table 6.3** the composition of the WHM is mention. It also proved that the physical and physiological properties of the crop also increased by using water hyacinth as a source of manure refer to ***table 6.1a and 6.1 b.***

Table 6.2 Manure quality, component and experimental results:

S/no-	Sample Plot	%Germination	Fresh Wt. (gm)	Dry Wt. (gm)	Bio mass	Shoot Length (cm)	Root Length (cm)	Root/Shoot Ratio (cm)
1.00	**Expt.**	44/50	13.85	1.24	12.59	15.99	14.75	0.92
2.00	**Control**	18/50	4.65	0.53	4.12	13.58	10.83	0.80

Table- 6.1(a) Physical parameters of wheat plants analysis Sharda and Girish, (2014)

S/no-	Sample Plot	Chl. A Content mg/g	Protein Content mg/g	Reducing Sugar mg/g
1.00	Expt.	11.14	0.31	0.72
2.00	Control	10.10	0.24	0.38

Table- 6.1(b) Physiological parameters of wheat plants analysis Sharda and Girish, (2014)

Control soil CNTR		**WHM**
pH	7.4	7.8
Total nitrogen (%)	0.161	0.86
Available phosphorus (ppm)	55.82	98.64
Potassium (C mol kg $^{-1}$)	1.18	2.96
Organic carbon (%)	3.39	4.42
Ca (C mol kg $^{-1}$)	30.72	49.79
Mg (C mol kg $^{-1}$)	3.05	6.88
Na (C mol kg $^{-1}$)	0.61	1.06
Zn (ppm)	2.71	3.21
Cu (ppm)	3.04	3.26
Mn (ppm)	231.78	272.54
Fe (ppm)	115.96	115.72

Table- 6.2 Mineral composition of most of the soil in the plots of the different crops (Nuka& Dubey, 2011)

WATER HYACINTH AS A SOURCE OF PHYTOREMEDIATION AND BIOFILTER

Water hyacinth (Eichhornia crassipes) is a noxious weed that has attracted worldwide attention due to its fast spread and congested growth, which lead to serious problems in navigation, irrigation, and power generation. On the

other hand, when looked from a resource angle, it appears to be a valuable resource with several unique properties. As a result, research activity concerning utilization (especially wastewater treatment or Phytoremediation) of water hyacinth has boomed up in the last few decades. Wastes resulting from water treatment operations (sludge) are usually discharged into surface waters. This method of disposal often causes the build-up of a sludge deposits in streams. The effects of sludge effluent has a characteristics such as dissolved oxygen (DO), nitrates and suspended solids on the environment have been established for sewage plant effluents. However, little work has been done on determining the levels of these parameters in water treatment plant effluents. The use of aquaculture as a means of treating wastewater involves both natural and artificial wetlands and the production of algae and higher plants (submersed and emerged), invertebrates and fish to remove contaminants such as manganese, chromium, copper, Zinc and Lead from the water. The water hyacinth (Eichhornia crassipes) appears to be one of the most promising aquatic plants for the treatment of wastewater and has received the most attention in this regard. The remarkable ability of aquatic plants, particularly the water hyacinth to extract compounds and elements from water efficiently has become well recognized. Presence of its fibrous root system and broad leaves help them to absorb higher concentrations of heavy metals. It readily reduces the level of heavy metals in acid mine drainage water and silver from industrial wastewater in short time. Phytoremediation is one of the biological wastewater treatment methods, and is the concept of using plants-based systems and microbiological processes to eliminate contaminants in nature. It is defined as the engineered use of green plants (including aquatic microbes, grasses, forbs, and woody species) to remove, contain, or render harmless such environmental contaminants as heavy metals, trace elements, organic compounds, and radioactive compounds in soil or water. Phytoremediation is a promising cleanup technology for contaminated soils, groundwater, and wastewater that is both low-tech and low-cost.

From the experimental analysis done by (Ajibade *et.al.*,2013) it can be observed that the variation pattern of most sewage characteristics measured in the water hyacinth plant density culture (1kg and 2kg) depicted by the rate of nutrient absorption when compared with the control treatment (no water hyacinth) could be best described as the graphs. There were drastic reduction in concentration of Chloride, Iron, Copper, Manganese, Lead, Fluoride, Sulphate, Nitrate, Phosphorus and Potassium. It is concluded that Eichhornia crassipes (water hyacinth) can be usefully employed to extract nutrients from sewage. It is also proved useful in treating effluents polluted with toxic heavy metals. The study reveals the potential and effectiveness of aquatic plant especially water hyacinth in the removal of nutrients on sewage. It can also be concluded that the higher the density of the plant (water hyacinth) on sewage, the more the absorption of nutrients (pollutants) that is, the best of purification will be obtained.

Conclusion

Water hyacinth is the solution of today's problems, in the context of pollution, economic aspects and also enhances the creative world of fashion & textile industries. This futuristic "wholesome plant" can mitigate the major

contaminants from the water bodies. WHM which is the promising organic fertilizer can be used in the crops to increase the crop productivity, without altering the soil properties in negative manner. Not only as a fertilizer it is helping but also helps to generate the income for the rural people by making handloom items from the parts of this plant. This plant can also prove beneficial for the livestock, as a feeding source. Proper management of this weed can check its population and also helps to generate income for sustainable livelihood.

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