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Water hyacinth: A wonder weed

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Abstract
Water hyacinth world's worst water weed found in more than 50 countries. It causes many problems. It affects ecosystem and peoples's livelihoods. A lot of money has been spent to eradicate the weed. This paper is a review on Water hyacinth plant , its composition and how the worst water weed could beneficial. There are many possible applications of Water hyacinth plant which is economically viable.

Keywords: Water hyacinth, physical properties, chemical properties, anatomical study, possible applications

Introduction
Water hyacinth is an aquatic plant which can live and reproduce floating freely on the surface of fresh waters. Plant size ranges from a few inches to a meter in height. Its rate of proliferation under certain circumstances is extremely rapid and it can spread to cause infestations over large areas of water causing a variety of problems. It grows in mats up to 2 meters thick which can reduce light and oxygen, change water chemistry, affect flora and fauna and cause significant increase in water loss due to evapo-transpiration. It also causes practical problems for marine transportation, fishing and at intakes for hydro power and irrigation schemes. It is now considered a serious threat to biodiversity.The plant is a perennial aquatic herb (*Eichhorniacrassipes*) which belongs to the family *Pontedericeae*, closely related to the *Liliaceae* (lily family). The mature plant consists of long, pendant roots, rhizomes, stolons, leaves, inflorescences and fruit clusters. The plants are up to 1 meter high although 40cm is the more usual height. The inflorescence bears 6 - 10 lily-like flowers, each 4 - 7cm in diameter. The stems and leaves contain air filled tissue which give the plant its considerable buoyancy. The vegetation reproduction is asexual and takes place at a rapid rate under preferential conditions (Herfjord, Osthagen and Saelthun 1994) [11].

Fig 1: Water Hyacinth Plan

Water hyacinth is an invasive species, which invades fresh water habitats and is listed along with some of the worst weeds (Center *et al*. 1999) [3]. Some countries have even placed this species in their quarantine list and banned their sale or movement within their sphere of influence. Water hyacinth is very difficult to eradicate by physical, chemical, and biological means, and a substantial amount is spent on their control annually throughout the world. It is also a very sturdy species.

It cause blockage of irrigation channels affecting the flow of water to fields, get entangled with motorboat rotors, making fishing difficult, and almost makes any place inhabitable and inaccessible. Water Hyacinth may block hydroelectric turbines causing enormous damage, which are vital for economy and green environment. They out-compete almost all other species growing in their vicinity thereby decreasing biodiversity (Crafter *et al.* 1992) [5]. They destroy the beauty of a given place, and sometimes can be a breeding ground for disease causing insects and pests. Water Hyacinth can also accelerate the process of evaporation from water bodies. They tend to absorb nutrients quickly thus making the ecosystems less fertile. This has had a large impact on the life of marginal farmers, increasing poverty in the less developed world.

It does, however, have some positive attributes. It is a gift, waiting to be accepted. And, as already stated, we have a moral imperative to use a source of biomass that is so abundantly available, in an age when the majority of the earth's valuable natural resources are being consumed as if there were no tomorrow. Such a perspective may not be easy to accept, given the dreadful hardship that it causes for so many people, and how utterly impossible its removal seems to be.

The positive attributes of Water hyacinth are:

- Abundantly available.
- Grows readily without any need for sowing, weeding or fertilizing.
- Does not require any land space.
- Costs nothing.

Physio-chemical characteristics of fresh water hyacinth plant

Analyzed the physico-chemical characteristics of fresh water hyacinth plant and the results are:

Table 1: Physio-chemical characteristics of fresh water hyacinth plant

Moisture	92.8%
Ash content	417 g kg-1
pH	8.1
Total Organic Carbon	338 g kg-1
Total Nitrogen	9.5 g kg-1
C: N ratio	36:1
Total potassium	9.7 g kg-1
Phosphorus	5.4 g kg-1
Total ferrous	1640 mg kg-1
Total copper	312 mg kg-1
Total cadmium	1.36 mg kg-1
Total chromium	41.18 mg kg-1
Total lead	67 mg kg-1
Total zinc	640 mg kg-1

According to Nyananyo *et al*. (2007) [18] the aquatic weed, water hyacinth (*Eichhorniacrassipes*), though a nuisance in public water bodies has high protein and total organic matter content, which makes a potential raw material for the production of animal feed and low cost alternative source of organic fertilizers. The compost obtained from water hyacinth has an acceptable composition of nitrogen -1.78 per cent, phosphorus -93 per cent, potassium -75 per cent, pH-8.4 and could be used in agricultural land for crop production.

Anatomical studies of Water Hyacinth

The plant parts i. e. rhizomes, roots, leaves and petioles harvested after 96 hoursare cut into 10-15 cm pieces and preserved in formalin-acetic acid-alcohol (FAA), a lethal chemical preservative. Manual sectioning is done to study the plant material in cross sections.

Epidermis of Petiole

- A single layered epidermis and composed of parenchyma cells.
- Cuticle is absent.
- Vascular bundles are embedded in outer parenchyma cells.
- Each vascular bundle has a bundle cap of sclerenchyma cells making up the petiole.

Petiole after 2 days Fresh Petiole with water content

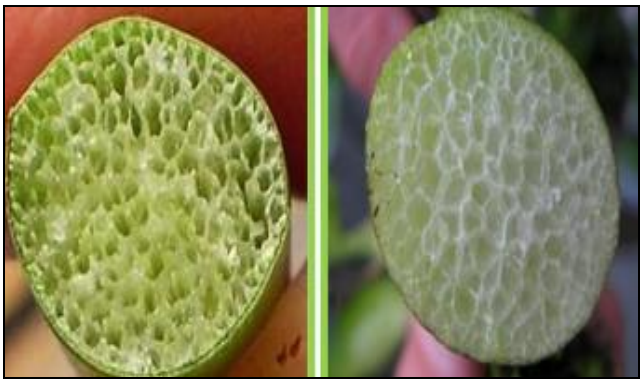

Fig 2: Cross sectional view of Petiole Processing of Bast Fibre

The conventional method for separating bast fibres is retting. Types of retting are: Dew retting, Water retting, Enzymatic retting, Chemical retting and Mechanical retting. Mainly Water, Dew and chemical retting are used in which water and dew retting requires 14-28 days to degrade the pectic materials, hemicelluloses and lignin.In recent years, agricultural lingo-cellulosic fibres have shown the potential to play an important role in the global energy future because they can be grown in a sustainable manner and converted into a variety of products (Wu *et al*. 2013) [22]. Various methods such as mechanical (Alang *et al.* 2011) [1], physical (Imanah and Okieimen 2004 [12], Iyasele and Okieimen 2004) [13], chemical (Nigam *et al*. 2009 [17], Cheng *et al.* 2010) [4], and steam explosion (Kristensen *et al*. 2008) [15] have been discussed to improve the processability of lingo-cellulosic fibres. Physical treatments include soaking/wetting,

Chopping, grinding, pelleting, steaming under pressure, and gamma radiation. Alkali, acid, and oxidative reagents are used in chemical treatments (docz.io/doc/3624100/peer-review-article).

Currently, biological treatment is receiving increased attention as a way to improve the processability of lingo-cellulosic fibres. Biological treatments include composting and fermentation, as well as fungal and enzyme degradation (Koike *et al*. 2014) [14]. Fibres prepared after retting process exhibited better mechanical properties than the un-retted fibres because they had more lignin like fibre surface (Sain and Panthapulakkal 2006) [19]. Also, the composting treatment is one of the widely used techniques to improve cellulosic fibres from agricultural plants such as hemp, flax and jute.

Water hyacinth has a fibrous stem (petiole). Its fibres could be extracted by chemical retting process. The cut, split stemsare air dried for 4-6 hours in the direct sun and then treated with sodium meta-bisulphite/aqueous KOH in required amount of water. Water hyacinth fiber is obtained from the stems (stalks) of the water hyacinth plant.

Table 2: Comparison of Composition of Water Hyacinth Fibres with Cellulosic Fibres

Cellulosic Fibres	Lignin	Cellulose	Hemi-Cellulose
Water Hyacinth	14	32	21
Flax	2.5	56.5	15.4
Hemp	2.9	78.3	5.47
Jute	12.9	59.4	18.92
Sisal	12	58	13

Water hyacinth fibre is taken from the stems (stalks) of the water hyacinth plant (*Eichhorniacrassipes*). The stalks of water hyacinth (*Eichhorniacrassipes*) are a viable natural source of alternative textile material, and the usage of water hyacinth varies across counties. Yarn or rope made from this fibre is used to make furniture, baskets. Vietnam is major exporter of furniture made of water hyacinth (www. westbengalhandloom. org).

Possible practical applications of water hyacinth

Although water hyacinth is seen in many countries as a weed and is responsible for many of the problems outlined earlier, many individuals, groups and institutions have been able to turn the problem around and find useful applications for the plant.

Paper: The Mennonite Central Committee of Bangladesh has been experimenting with paper production from water hyacinth for some years. They have established two projects that make paper from water hyacinth stems. The water hyacinth fiber alone does not make a particularly good paper but when the fiber 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. Small-scale cottage industry papermaking projects have been successful in a number of countries, including the Philippines, Indonesia, and India.

Yarn and rope: The fiber 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 meta-bisulphite to prevent it from rotting. In Bangladesh, the rope is used by the local furniture manufacturers who wound the rope around a cane frame to produce an elegant finished product.

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:

Conclusion

It can be suggested from present review that water hyacinth, a noxious weed can be a potential source of sustainable income if cottage industry is established in areas that are nearby to its plentiful occurrence. It is expected that rural people will be benefited, by way of collecting, drying, supplying thereby adding to their income. It will also help in eradicating this weed, thus, simultaneously reducing water pollution. Water hyacinth has shown a great potential in textile and paper industry**.**

Water hyacinth is available across all the parts of the world. In India this weed was introduced in 1896 as an ornamental piece at the botanical garden in Bengal. India has not yet fully explored the potential of this plant except for some groups in South India. In India, water hyacinth is traditionally used for manufacturing paper (as cottage industry), for making baskets and matting.

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