



HARNESSING THE POWER OF NATURE: COMPOSTING WATER HYACINTH AS A SOLUTION TO WATER POLLUTION

AJAY KUMAR BAHELIYA^{1*}, KRISHNA KUMAR PATEL², VIKAS YADAV¹, DHARMENDRA KUMAR¹

¹Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh; ²Chandra Shekhar Azad University of Agriculture and Technology, Ayodhya, Uttar Pradesh

*Corresponding author, E-mail: ajaybaheliya110125@gmail.com



Water pollution is a major threat to aquatic ecosystems and human well-being. The escalating issue of water pollution, resulting from the industrialization, urbanization, and agricultural activities, profoundly impacts the aquatic ecosystems and its life forms. While addressing this challenge, role of water hyacinth, a troublesome fresh water plant and a major contributor of water quality deterioration of lakes and other water bodies, cannot be ignored. But, the potential

of this aquatic weed goes beyond the environmental pollution it creates. Known for rapid growth and water coverage, water hyacinth can be converted into nutrient-rich compost, offering significant benefits to soil health and fertility in the realm of sustainable agriculture. Recent research also highlights water hyacinth as a sustainable resource particularly for composting. This approach transforms a problem into an opportunity for a natural and eco-friendly solution.



UNDERSTANDING WATER HYACINTH

Water hyacinth (*Eichhornia crassipes*) is native to tropical and sub-tropical South America, has spread to over 80 countries and is present in various wetlands. It not only impacts water flow but also blocks entry of sunlight to water, reduces oxygen level for fish, affects nutrient levels in water, interferes with water treatment and irrigation and creates ideal habitats for the growth of mosquitoes and snails. Since methods to control this aquatic plant is limited it is better to explore its benefits by converting it to some valuable products. Recognized for its effectiveness in tackling organic matter depletion and soil erosion, this fast-growing plant plays a key role in replenishing soil nutrients.

Water hyacinth acts as a natural fertilizer factory, accumulating high levels of macronutrients Nitrogen (N), Phosphorus (P) and Potassium (K). Upon decomposition, these nutrients become readily available to plants. Sindu et al. (2015) reported the N supplying power of water hyacinth as a storage capacity of up to 3.2% in its dry mass and a favorable carbon-to-nitrogen ratio, ideal for nutrient release. Incorporating water hyacinth as a green manure or compost goes beyond providing nutrients since it helps in improving soil health through better soil aeration, water retention, and microbial activity. Ultimately, this translates to increased yields, benefiting farmers and food security.

WATER HYACINTH AS A BIO INDICATOR

Water pollution is a multifaceted issue that arises due to various reasons like industrial discharges, agricultural runoff, untreated sewage etc. Most of the polluted water bodies contain heavy metals in high quantities. Studies showed water hyacinth tissues contain around 187 mg/kg of lead (Pb), conveys severity of heavy metal contamination in water resources. Unique ability of this plant to accumulate pollutants made it famous as a bio indicator plant among scientists and environmental managers.

Nutrient Uptake and Eutrophication: Studies of Abdalla and Elballah, (2015) shown water hyacinth readily accumulates primary nutrients like N, P and K, reflecting the nutrient profile of water. Water hyacinth tissues containing 2.8% N, 0.6% P and 1.5% K mirroring

nutrient levels in eutrophicated lakes. This data provides valuable insights into potential eutrophication risks and allows for informed management strategies.

Heavy Metal Bioaccumulation: Water hyacinth has exceptional potential for absorbing heavy metals such as lead (Pb), mercury (Hg), and cadmium (Cd). In India, heavy metal concentration of 42 mg/kg Pb, 0.3 mg/kg Hg and 0.2 mg/kg Cd was detected in the water hyacinth tissues from polluted waterways. Water hyacinth plants reportedly absorb heavy metals rapidly through roots and can concentrate up to 0.67 mg Cd and 0.50 mg Ni per gram of dry plant material in 24 hours if exposed to water contaminated with 0.578 to 2.00 ppm of these metals (Rai and Tripathi, 2009). It was determined that one hectare of water hyacinths could potentially remove 300 g of cadmium or nickel from 240,000 liters of metal-polluted water within a 24-hour period.

Organic Pollutant Monitoring: Tissues of this plant act as repository of various organic pollutants including pesticides, herbicides, and pharmaceuticals. Goyal et al. (2005) reported the bioremediation potential of this plant especially in removing herbicide residues from polluted water. This also reflects contamination of water bodies due to runoff from agricultural lands.

COMPOSTING OF WATER HYACINTH

Composting is a natural decomposition process that converts organic materials like water hyacinth into nutrient-rich humus. The process transforms huge volumes of plant material into a valuable soil conditioner and prevent the release of nutrients and pollutants into water (Cerveira *et al.*, 2019). Composting of water hyacinth involves collecting water hyacinth from affected areas, shredding the material, and subjecting it to controlled composting.

Composting ensures the organic matter breaks down, eliminates potential pathogens, and optimizes nutrient availability, benefiting both ecosystems and soil health. Composting diverts huge quantities of water hyacinth from being dumped as landfills or burning, thereby, preventing the negative environmental impacts of those activities.



Habitat Restoration: Removing water hyacinth through composting helps to reduce the volume of water hyacinth significantly in waterways. This ensures proper flow of water, improves oxygen levels, and allow native plants to thrive that also helps restoring biodiversity and ecological balance.

Pollutant Removal: Utilizing water hyacinth for composting serves dual purpose of managing this invasive plant and promoting environmental sustainability. Composting process facilitates breakdown of pollutants absorbed by water hyacinth viz., heavy metals, pesticides, and excess nutrients, reducing the overall burden on water bodies. By capturing and immobilizing nutrients and pollutants from water hyacinth, composting prevents them from entering the broader aquatic ecosystem, reduces harmful algal blooms and protects water quality.

Nutrient Recycling: Water hyacinth is rich in essential plant nutrients required for growth and development of crop plants. Through composting water hyacinth, nutrients absorbed by this plant from the aquatic ecosystem will be converted to an organic manure, and application of this in agricultural lands enable returning of valuable nutrients back to the soil.

Improving Soil Health and Crop Yield: The nutrient rich organic material produced through composting is a valuable soil amendment which helps in maintaining soil health of agricultural lands by improving the physical, chemical and biological properties of soil. Water hyacinth compost is beneficial for a wide range of crops, including cereal crops, fruits and vegetable crops. Its versatility makes it a suitable option for farmers cultivating diverse crops in different agro ecological zones.

Biocontrol Properties: Water hyacinth compost possesses natural biocontrol properties and it can effectively suppress certain soil-borne pathogens and pests as per some research reports (Kumar et al, 2020). This eco-friendly aspect makes it an ideal choice for eco-friendly farming practitioners and helps other farmers to reduce the need of chemical pesticides.

Green Energy Production: Water hyacinth compost can be utilized in bioenergy production, contributing to renewable energy sources. This not only addresses waste management issues but also promotes a circular economy.

Community Engagement: Involving local communities in the composting of water hyacinth helps to create awareness about how to convert waste to wealth and also the importance of protecting precious natural resources. Community participation fosters a sense of responsibility and stewardship toward natural resources.

CHALLENGES AND CONSIDERATIONS

While composting offers a promising solution for managing problematic weeds like water hyacinth this recycling process has a number of challenges too. Cleaning of water bodies for water hyacinth collection is highly labourious and mostly done manually. Manual harvesting of this aquatic plant is relatively less costly but it is physically demanding, inefficient, and carries risks of injury to workers as well as aquatic life. While mechanical options like mowers and dredgers address these concerns, their high initial cost can be a barrier if composting is done by individual farmers. Further, since water hyacinth absorb heavy metals from polluted water, their transfer to the soil through compost and its potential risks to soil and human health is a matter of concern. This demands proper knowledge and experience for monitoring and taking precautions during the composting process and its application in agriculture fields. Hence, awareness creation and training of personnel are essential for the successful adoption of this sustainable practice.

Breakdown of water hyacinth is hindered by its composition. Lignin, cellulose and hemicellulose, which are complex molecules resistant to microbial attack. Though water hyacinth's strength comes from its unique blend of these compounds, its composition is challenging for microorganisms to decompose the plant efficiently. However, achieving optimal water hyacinth compost quality necessitates accelerating the degradation of these recalcitrant components during the composting process. Inoculation of exogenous ligninolytic microorganisms and utilization of rotary drums for composting process can facilitate the efficient bioconversion of these recalcitrant polymers.



CONCLUSION

Beyond tackling water hyacinth menace, composting unlocks its hidden potential as a powerful environmental ally. It's not just about waste management; it's a holistic approach for resolving diverse challenges like ensuring clean water by removing pollutant elements; recycling of waste for environmental benefits and ensuring food and nutritional security; alternative clean energy sources for local communities through bioenergy/biogas production etc. Local participation in the composting process leads to the empowerment of communities through knowledge and additional income. The key to realizing this vision lies in collaboration of public and private entities. Involvement of Government agencies are necessary for investing in research, infrastructure development, and training programs. Environmental organizations should provide technical expertise and community support. Local communities should participate in implementing and scaling up these initiatives. By embracing water hyacinth composting as a nature-based solution, we can safeguard our water resources, restore soil health, and build resilient communities for generations to come.

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