

PRODUCTION OF PAPER FROM WATER HYACINTH

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Science degree in Microbiology

By

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INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Joesh Noel Antony B. (38770008) and P.R. Aishwariya(38300001) who carried out the project entitled **"PRODUCTION OF PAPER FROM WATER HYACINTH"** under our supervision from OCT 2020 to MAR 2021.

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DECLARATION

I JOESH NOEL ANTONY B. J hereby declare that the Project Report entitled **“PRODUCTION OF PAPER FROM WATER HYACINTH”** done by me under the guidance of **Dr VALLI NACHIYAR** at Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Science degree in Biotechnology.

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I P.R. AISHWARIYA hereby declare that the Project Report entitled **“PRODUCTION OF PAPER FROM WATER HYACINTH”** done by me under the guidance of **Dr. S .SUDHA** at Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Science degree in Microbiology.

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ABSTRACT

Water hyacinth (*Eichhornia crassipes*) is a monocotyledonous freshwater aquatic plant of Pontederiaceae family. These plants were firstly introduced as an ornamental crop species in many countries more than a century ago. This was just because of their attractive blue, lilac to purplish flowers and round to oval leaves. The main problem with water hyacinth is that it creates dense mats of biomass on water surface which are reducing light to submerged vegetation, thus resulting in oxygen depletion and fish kills. Now as the demand of paper is increasing we need to find an alternate source for the production of paper. Water hyacinth contains high quality fibres and fiber pulp which can be used in the process of paper making. This method hence utilizes water hyacinth as a raw material which also helps to protect the environment and therefore solves the problem created by water hyacinth such as blockage of water transport which results in the hazard in global traffic. Henceforth we economically utilize these natural resource by the concept of eradication through utilization. In this method the water weed is converted into pulp and is used to make paper or paper products. The idea of production of paper from water hyacinth not only help in country's economy but also leads to development of sustainable development .

Keywords: Water hyacinth , *Eichhornia crassipes* .

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LIST OF ABBREVIATIONS

NCBI	National Centre for Biotechnology Information
pH	Potential of Hydrogen
BOD	Biological oxygen demand
IGT	Institute of Gas and Technology

CHAPTER 1

INTRODUCTION

1.1 WATER HYACINTH

Water Hyacinth (*Eichhornia crassipes*) is a free-floating perennial aquatic plant . They are one of the fastest –growing plants(NCBI) .The large, purple flowers make it a favourite ornamental plant. In Bangladesh it is known as the “German weed”, the “Florida Devil” in South Africa , the “Terror of Bengal” in India and the “Japanese Trouble” in Sri Lanka. These plants grows very fast and therefore it can double its population in a matter of two weeks. They are obligate aquatic plant which forms dense free-floating mats and derives all of its nutrients from the water. These plants reproduces primarily by way of runners or stolons, which then forms daughter plants. Some of them were found to grow between 2 and 5 meters (7 and 16 feet) a day in some sites in like Southeast Asia. The common water hyacinth (*Pontederia crassipes*) are generally vigorous growers and mats can double in size in a duration of one to two weeks

The interesting fact was that the Water Hyacinth was a gift of the British to India, which was introduced towards the end of the 18th century. It was brought to India by Lady Hastings, the wife of the First British Governor-General, who was enchanted by the beauty of the flowers . Therefore now it has spread to most water bodies.The major problem comes when the water hyacinth causes dense mats of biomass on the water surface, which as a result reduces dissolved oxygen in the water and also the amount of light available to the underground vegetation .Thus causing an imbalance in the aquatic ecosystem which also affects

the fish population. These plant also ruins the natural wetlands and causes flooding by blocking rivers ,canals, and lakes .

The flowers produced by water hyacinth are pollinated by long-tongued bees and hence reproduce both sexually and clonally. Water hyacinth reproduce sexually by producing seeds through flowers whereas asexually by budding through vegetative reproduction systems. These are invasive plants that doubles itself within 5 -15 days. Favourable conditions for its growth are nutrient- rich water, temperature ranges from 28° C to 30°C ,salinity <2%, pH value between 6.5 and 8.5 , 20 mg/L N ,3 mg/L P, and 53 mg/L K.

As water hyacinth is referred as the most invasive aquatic plants therefore it is known to cause both ecological as well as socio-economic effects . The major problem is that when it forms thick mats which results in enormous water loss through evapotranspiration, that can lead to increase in sedimentation, causing flooding and soil erosion.

Water hyacinth for these reasons are considered as the worst weed in the world. There are many more negative impacts of water hyacinth such as it causes a drastic change in the physical and chemical properties of water ,like BOD, main cause in the reduction of the activity of electrical power stations ,jeopardizing the power supply of the country; and also a serious threaten to agriculture production, all these at last leads to the blockage of irrigation canals and drainage systems. Water hyacinth represents an environmental problem and also indirectly a public health problem. Therefore the economy of the country is seriously affected in many aspects .

They are termed as “tristylous” as they have three flower morphs .Water hyacinth are also one of the most noxious weeds in tropical and subtropical regions and many attempts had been made for the removal and control of these plants.

However, it's not all that bad about water hyacinth ;we can also see certain advantages of the these plant. Such as the plant thrives in highly polluted waters that reduce the level of pollutants in the water, thus helping to tackle the widespread issue of water pollution through a process known as phytoremediation. Research has made us to believe that the plant is capable of cleaning up polluted industrial wastewater of toxic heavy metals such as chromium and crude oil. Also day by day technologies are being developed to utilise water hyacinth as a green fuel and to make paper and paper boards. It is also providing a good source of income to people in villages as they can earn money by making handicrafts by these plants.

So, we need to do is to make the best of this plant .Therefore, instead of trying to destroy these species, the invasiveness and massive proliferation of these plant could be utilised for the benefit of the environment(IGT).

1.2 PRODUCTION OF PAPER FROM WATER HYACINTH

An attempt was made in Bangladesh in 1980, to produce paper from water hyacinth, but their results at first was not as expected. It was not at all easy to make paper from a plant like this. Sometimes the paper wouldn't dry, it was weak and the colour was not pleasant . These plants can absorb a lot amount of water in a short period of time. Samudra Sokh is the hindi name for water hyacinth which means species who can absorb an ocean. Water hyacinth is cellulose rich plant which grows rapidly in ponds soft and easy to process and hence they can be an alternative source of material for paper making. Researchers say that paper made by dry petiole and root showed better tensile strength than compared to other body body parts. The leaves of these plants are rich in protein, the plant has a fibrous stem and a high concentration of potassium. Water hyacinth are considered edible not only for animals but for humans too. Stalks and leaves of these species are added in soups in country like Thailand. Paper produced by these plants can help in the development of country both economically and socially.

1.3 CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT

Water hyacinth holds a very important role in sustainable development. The plant is considered to be aggressive and has been a terrible nuisance for more than 100 years on almost all of the continents .The problem has grown in such proportions that the government itself is not able fix it .It was noticed that there isn't one particular method that could offer long term solution. Thus an approach was made to produce handmade paper from the biomass of the water hyacinth. These species serve as an alternative source in the process of paper making and also give out less chemical waste. This results in the sustainable development of the country.

CHAPTER 2

LITERATURE REVIEW

A review of completed and ongoing research has been conducted to identify current knowledge or methodologies in production of paper by water hyacinth (*Eichhornia crassipes*). The review of literature and research have been summarized and are described in the following section:

- To scrutinize the benefits of water hyacinth.
- Analysis of water hyacinth as an alternative source for the production of paper.
- Quality of paper produced after the process.

In a study Neelu Das and Shashikanth Singh studied the evaluation of water hyacinth stem ash as pozzolanic material. The study was helpful and useful in blended cement. The study was all about the potential utilization of water hyacinth stem slag in the halfway substitution of bond.

1) R. M. Kutty, Here it was described Water hyacinth has been used in aquatic systems for waste water purification for many years. Also the role of water hyacinth (*Eichhornia crassipes*) species in polishing nitrate and phosphorus concentration from municipal wastewater treatment plant effluent by phytoremediation method was evaluated. Here the main objective is to determine the removal efficiency of water hyacinth in polishing nitrate and phosphorus, as well as chemical oxygen demand (COD) and ammonia. Water hyacinth is considered as the most efficient aquatic plant used in removing a vast range of pollutants such as organic matters, nutrients, and heavy metals.

2. Piyush Gupta^{1,*}, Surendra Roy¹, Amit B. Mahindrakar² stated that Phytoremediation techniques for the treatment of different types of wastewater have been used by several researchers. These techniques are reported to be cost effective compared to other methods. Various contaminants like total suspended solids, dissolved solids, electrical conductivity, hardness, biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, nitrogen, phosphorous, heavy metals, and other contaminants have been minimized using water hyacinth, water lettuce, and vetiver grass. In this paper, the role of these plant species, origin and their occurrence, ecological factors and their efficiency in the reduction of different water contaminants have been presented.

3. Chibueze G. Achi describes that Phytoremediation technology is an age-long concept, which utilizes aquatic or terrestrial macrophytes in the treatment of wastewaters. This study assessed the performance of a water hyacinth based wastewater treatment plant at University of Ibadan, Nigeria. This treatment plant was built with a view of treating institutional wastewater which was otherwise polluting the Awba lake, a source of drinking water on the campus. Wastewater samples were collected at the influent point (IP) and effluent point (EP) of the treatment plant. The samples were analyzed for physicochemical parameters, viz. Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS).

4.D. L. Klass and S. Ghosh stated that Water hyacinth (*Eichhornia crassipes*) is an aquatic biomass species that exhibits prolific growth in many parts of the world. It has been suggested as a strong candidate for the production of methane because of high biomass yield potential. Several studies have been carried out which establish that methane can be produced from water hyacinth under anaerobic digestion conditions. Both batch and semicontinuous digestion experiments were performed. The highest apparent gas yields reported were obtained in the batch mode of

operation over long detention times, but the yields were based on wet hyacinth containing unspecified amounts of water and ash.

5. Y. Nuraini *, M. Felani stated that The objective of this study was to elucidate the possible phytoremediation of liquid waste of tapioca industry using *Eichhornia crassipes* prior its usage for watering maize grown on an Entisol of Malang. Tapioca liquid waste was mixed with pure water at various concentrations and then *Eichhornia crassipes* was grown on a water bath filled with the mixture. After twenty-eight days, the mixture of tapioca liquid waste and pure water was analyzed for BOD, COD, DO, TSS, CN, total N, and total P, prior to its usage for watering maize grown in a pot filled with an Entisol. Results of this study showed that during twenty-eight days *Eichhornia crassipes* grown on 25% tapioca wastewater was capable of reducing BOD, COD, and CN concentrations of the liquid waste and to increase pH of the mixture of liquid and pure water. This has resulted in a significant increase of maize growth.

6. Trinidad Ruiz Téllez* stated that the recent invasion of water hyacinth *Eichhornia crassipes* (C. Mart.) Solms (1883) in the Guadiana River Basin (Spain) is described and the distribution of this Amazonian floating plant is analyzed from a geobotanical perspective. Geo referenced locations of invasion in Spain and Portugal are presented and the relative growth rate (RGR) and doubling time (DT) indexes defined by Gopal (1987) were calculated. The sexual reproductive cycles were determined in order to evaluate the invasive capacity at these latitudes. Predictive models of the plant's potential distribution in the Guadiana River were constructed based on expert knowledge and using a Geographic Information System, on the basis of the water's physicochemical parameter.

7. Paul Njogu¹ stated that Water Hyacinth, *E. crassipes*, an invasive water weed thrives in fresh water bodies causing serious environmental problems.

In Kenya the weed has invaded Lake Victoria and poses great socioeconomic and environmental challenges. Currently, the weed is harvested from the Lake and left in the open to rot and decay leading to loss of aesthetics, land and air pollution. There is, therefore, need for the development of value addition and economic exploitation strategies. The aim of the study is to assess the potential for utilization of the weed as a renewable energy resource for biogas production. Samples were collected from Lake Victoria, pulped and blend with cow dung at a ratio of 3:1 as inoculum. The resultant mixture was mixed with water at a ratio of 1:1 and fed into a 6 m³ tubular digester. The digester was recharged with 20 kg after every three days. The temperature, pH variations, gas compositions, upgrading and gas yields were studied. The temperature ranged between 22.8°C - 36.6°C and pH 7.4 - 8.5. Biogas was found to contain 49% - 53% methane (CH₄), 30% - 33% carbon dioxide (CO₂), 5% - 6% nitrogen (N₂) and traces of hydrogen sulphide (H₂S). The biogas was upgraded using solid adsorbents and wet scrubbers increasing the methane content by up to 70% - 76%. The upgraded gas was used to power internal combustion engines coupled to an electricity generator and direct heat applications. The study concludes that *E. crassipes* are a potential feedstock for biogas production especially in areas where it is abundant

CHAPTER 3

AIM AND SCOPE

The objective of present work is to evaluate water hyacinth as an alternative source in the process of paper production by studying the plant's physiology.

- To analyze product made out of water hyacinth for economical use .
- To design and produce handicrafts or making paper board by using water hyacinth as a source. .
- To analyse the economic benefits derived from water hyacinth.
- To determine water hyacinth as a sustainable source for various products.

CHAPTER 4

MATERIALS AND METHODS

4.1 COLLECTION OF WATER HYACINTH

Water hyacinth was collected from two different places that is from Velachery lake and Pallikaranai wetland which is in Chennai, Tamil Nadu. It was observed that these weeds have occupied the surface, more than one third of the lake's area was occupied with these species. Water hyacinth is one of the fastest growing plants and it reproduces very quickly within a short period of time. Therefore, we collected water hyacinth from these two localities. After the collection we brought these species and stored it in a large container containing water.

4.2 CHOPPING OUT LEAVES AND ROOTS

After the collection of water hyacinth from lakes which was stored in large containers, the next step in this process is chopping out the leaves and roots. The leaves and roots are chopped out with the use of scissors or knife. Only the stem are taken and the rest is discarded.

4.3 CUTTING OF STALKS INTO PIECES

The stalks or the stem are cut into pieces with the help of scissors and these stalks are kept in a separate container. This is done because cutting the stalks into pieces might help in completing the whole process much more faster.

4.4 BOIL UNTIL COOKED

In this step the separated stalks stored are shifted into a large vessel where all the stalks are kept. After this step the vessel containing stalks is filled with water. After filling water in the vessel the next step was that the vessel was kept on the stove. The chopped stalks were then cooked in low flame for about two to three hours. The chopped stalks are boiled until it is cooked properly or until it appears brownish in colour.

4.5 RINSE

After the stalks are properly cooked they are taken out in a separate container. This step involves rinsing, where the stalks are rinsed with water. This step is performed twice.

4.6 ADDITION OF RECYCLED PAPER OR WASTE PAPER

This step is performed once rinsing is completed. In this step we added waste paper or the recycled paper into the container containing cooked stalk. Addition of waste paper is done before the step where these are blended into pulp.

4.7 BLENDING INTO PULP

After performing the above steps the next step done was to shift the stalks containing recycled paper into a blender. This step is done to mix the recycled paper with the cooked stalks. Blending is performed until the contents turn into pulp. This step may take some time because the complete mixture must be converted into pulp.

4.8 ADDING CASSAVA STARCH

After the conversion of the materials into pulp the next step performed to take out the pulp in a separate container. After that Cassava starch was added in the container containing the pulp. The main motive of this step is that cassava is used as a thickner ,binder, expanding agent ,and stabilizer which plays a major role in paper production from water hyacinth.

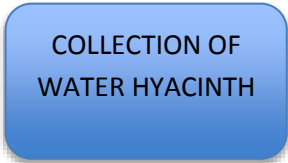
4.9 MIXING THE PULP WITH WATER

After performing the previous step the pulp is mixed with water .For performing this step water is added in the vessel containing the pulp. After the addition of water the mixture is mixed so that the water mixes with the pulp properly.

4.10 DRYING

After performing all the above steps the last step was performed that is the mixed pulp was arranged in a circular frame made of wooden or any other material for the purpose of drying. Then the frames are kept under the sun for drying for atleast 2 to three days.

PROCEDURE OF MAKIING PAPER WITH WATER HYACINTH



COLLECTION OF
WATER HYACINTH



CHOPPING OUT
ROOTS AND LEAVES

CUTTING THE STALKS
INTO PIECES



BOIL UNTIL
COOKED



RINSE

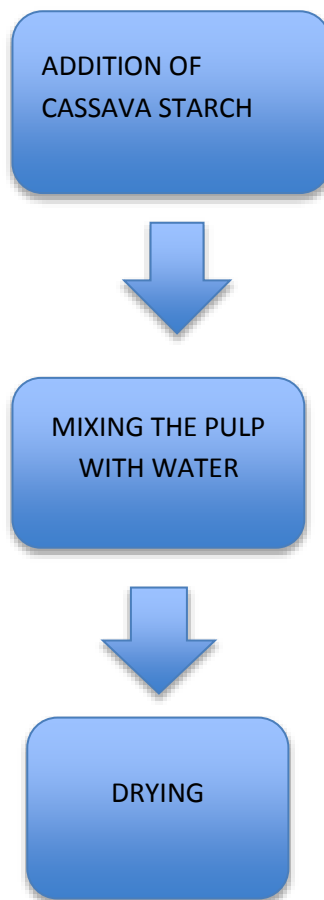


ADDDITION OF
WASTE PAPER



BLENDING INTO PULP





CHAPTER 5

RESULTS AND DISCUSSION

5.1 COLLECTION OF WATER HYACINTH (*Eichhornia crassipes*)

Water hyacinth was collected by us from two different places in Chennai that is the Velachery lake and Pallikaranai Lake. The lake was occupied by the water hyacinth as shown in the given figures .



(a)



(b)

FIG 5.1: (a)and (b) Collection of Water hyacinth

5.2 CHOPPING OUT ROOTS AND LEAVES

We chopped out the roots and leaves of the water hyacinth and discarded the

roots and leaves.



Fig 5.2 : Chopping out roots and leaves

5.3 CUTTING STALKS INTO PIECES

Then with the help of scissors the stalks was cut into pieces by us .This is shown as under



Fig 5.3 Cutting stalks into pieces

5.4 BOIL UNTIL COOKED

The chopped pieces are then shifted into a vessel where we added water and kept it for boiling in low flame for approximately 2 to 3 hours. This process is done until the stalks are cooked properly.



(a)



(b)

(c)

Fig 5.4: Boiling

5.5 RINSING

After boiling we rinsed the cooked stalks twice as shown under :





Fig 5.5: Rinsing

5.6 ADDITION OF RECYCLED PAPER OR WASTE PAPER

In this step we added recycled paper into the cooked stalks.



FIG 5.6: Addition of waste or recycled paper

5.7 BLENDING INTO PULP

Then after this step the contents are kept for blending with the help of a blender till the contents turn into pulp .



FIG 5.7: Blending into pulp

5.8 ADDING CASSAVA STARCH

Then addition of cassava starch was done by us as shown under:



Fig 5.8 :Addition of Cassava starch

5.9 MIX THE PULP WITH WATER

After the previous step water is added to the vessel containing pulp.



FIG 5.9 Addition of water into pulp

5.10 DRYING

Last but not the least what we did was prepared a circular frame for drying the pulp .Then we kept it under the sun for atleast 2 to 3 days .



Fig 5.10 :Drying

5.11 RESULT

After all the steps we observed the formation of paper, this paper can be used as paper cards or paper boards and also can be used many for other purposes.



(a)



(b)

Fig 5.11 : Paper produced by water hyacith

CHAPTER 6

SUMMARY AND CONCLUSIONS

The work is based on the analysis of water hyacinth as an alternate source or as a raw material in the production of paper from water hyacinth. Based on the result on the work done we highly recommend the use of water hyacinth for paper production. In processed a high versatile paper also and it was durable compared in those which is commercially available.

By looking on to the fiber we can indicate that the water hyacinth may be good material for pulp and paper making. Therefore, water hyacinth can be utilized for making medium quality paper and paperboards.

We strongly recommended you to use other pulps like wasted paper pulps with the blended water hyacinth pulp. The reason behind this is that it helps to minimize the shrinkage paper during drying. As a result the Paper made from water hyacinth is durable, flexible, and extremely versatile.

Over the last few decades, many experience has been acquired for the various methods of control, such as mechanical removal, chemical herbicides and the introduction of natural predators. But at the end, it was observed that only a combination of all these methods, with also having the knowledge of the local situation can be the solution..

Therefore even this method of pest management couldn't achieve the goal of total eradication of the water hyacinth. The problem with this growth of the water hyacinth is now so extensive that many solution are being planned for the

permanent solution. Therefore , useful applications are now being planned for the water hyacinth.

In our study we come into a conclusion that the water hyacinth is an aggressive plant, and it forms a major problem if left as it is without finding a solution .The problem can be solved by bringing solutions that not only is beneficial for country's economy but also promises us in sustainable development. In our study we analysed the production of hand-made paper from the biomass of the water hyacinth.

Water hyacinth does harm both socially and ecologically. Rivers containing water hyacinth sample are exposed to number of social problems that is because of the presence of water hyacinth. These plants are still a problem in the water bodies Many residents, organisations, the local government are trying to eradicate this plant and also trying to convert it into a resourceful material .

The study showed that the plant can be used as a source material in the paper making process. The paper made out of these plants can be used as paper and boards like file covers , greeting or invitation cards as well.

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