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Research Article

Tensile Strength of Paper Produced from Different Body Parts of Water Hyacinth

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Abstract

As a floating aquatic plant, water hyacinth is one the quickest growing plant of this earth. Water hyacinth is considered as a lignocellulose plant and that is why the paper making process that uses in other cellulosic materials can be applied to this plant. This article was focused to check the feasibility of producing paper from water hyacinth and check which portion of the plant is suitable for producing paper. Paper was made with different parts of water hyacinth like root, petiole, leaf, stolon and whole plant. Paper made by Dry petiole and root showed better tensile strength than other body parts and various natural colored paper was possible to produce from a plant.

Keywords: *Water hyacinth, paper, tensile strength.*

1. Introduction

Water hyacinth is one of the natural materials which is used to produce different sustainable products due to its availability and cost less property like fertilizer, feeds a practical and profitable byproduct of waste treatment, handicraft and some country uses this a cattle feed. But those are not enough use of it compare to its growth rate. So, if we want to utilize its abundance need to think about its large scale use. From that point of view paper production idea was generated was worked on it.

The growth rate of the water hyacinth is very high among any known plants. A single plant can give millions of seed and those seeds can remain healthy until five years. If we give it a chance to grow it can cover our whole world within one and a half years. In Florida, water-hyacinth populations can double their size in as little as 2 weeks by sending off short runner stems that develop new plants (daughter plants). Water hyacinth also can reproduce by seeds. For its excess growing rate, among 50 countries already band it and consider it as a million-dollar weed. This million-dollar weed can be converted as a billion-dollar raw material in paper production.

The water hyacinth plant grows vigorously and abundantly to produce large biomass and has leaves rich in protein, being as valuable as that in potatoes or clover. The plant has a fibrous stem and a high potassium concentration. Water Hyacinth is edible, not only for animals but for people too. Stalks and leaves are added to soups in Thailand. It was tough, fibrous roots that purify water, by absorbing the nitrogen and phosphorus on which it thrives, and also many other substances that pollute freshwater, including minerals. It absorbs toxic chemicals such as lead, mercury and strontium 90 in concentrations 10,000 times that in the surrounding water (Aoi, T., *et al*, 1996).

Water hyacinth has faster capacity of proliferation than any known water plant and it can develop up to 20 years. In ideal condition, a plant can produce 2.7 daughter plants per one week and theoretically could produce 28000 tons of water hyacinth in one year (Chanana B., *et al*, 2019).

Several researchers tried to utilize this plant as an energetic agent in various digestion process. The quantity of lignin (10%) opens the thermochemical and biochemical process possibilities. For producing biogas anaerobic digestion process can be considered and this biomass needs to treat chemically and thermally before use directly. The conducted experiment shows the thermal pre-treatment increases the volatile solids contents at law temperature from 57% to 74%(w/w) where ash contents also decreases (Crlini M. *et al*, 2018). Its fermentation process can be improved by activated carbon, dilute sulphuric acid with cellulose (Cheng j., *et al*, 2015).

Researches also worked with water hyacinth to purify raw sewage. In a research, it was found that this plant progressively purifies water by absorbing

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nutrients from sewage up to the fourth week testing time (19B. B. Ayade,98). Chromium (VI) of waste water can be adsorbed by the root of water hyacinth and its success rate is very high (100%) (Sarker D., *et al*, 2010).

Researcher in different purposes used water hyacinth but nobody attempted to produce paper. This gap tended us to select this topic a research topic.

2. Materials and methods

The excess of water hyacinth in our area is more due to the availability ponds. We collected water hyacinth from a pond near at Mawlana Bhashani Science and Technology University, Santosh, Tangail, Bangladesh. Every part of water hyacinth like root, leaf, stolon, green and dry petiole and whole body are used except the flower. That will make sure the proper use of the plant and its disappearance from the environment. NAOH is being used for help in grinding the fibers in blender machine. This chemical is widely used in paper industries for its minimum price and availability. Acetic acid is another chemical, which is use for proper neutralization. Nylon strainer, bikers, frames for producing paper, mesh fabric, pressure cooker, digital weight meter was used to produce and calculate GSM of paper.

2.1 Collect Suitable part from water hyacinth

Every part of the water hyacinth has used as a raw material for producing paper. We used the whole part of it and also different parts like green stem, dry stem, leaf, root, stolon, etc. for producing the different samples. For every sample, we can use it directly except dry stem. For the dry stem sample, we need to collect the stem from this plant and dry it first. One single pant has 7-12 stem where 5-6 mature stem has collected as a raw material for better results. For better drying, we divided every stem into 2 or 4 pitches. After proper drying it, ready for the next process. For other raw materials, we do not need to dry. We can purchase it directly by using a single wash.

Figure 1: Different parts of Water Hyacinth

2.2 Cut into small pieces

Every raw part has to cut into 1-3 inch for better boiling and better results for producing pulp.

Figure 2: Different chopped pieces of different body parts

2.3 Boiling with NaOH

Separately raw materials were cut and cooked on an electric cooker with mixing the fibers with water and NaOH. NaOH is the main chemical for producing paper in this project. We have used 2-5% of NaOH for different water hyacinth samples. The boiling time and temperature for water hyacinth was 30-50 min time and 80^0C -100^0C. After boiling, we have used (30-60) min for cooling.

Figure 3: Boiling with NaOH

2.4 Washing and neutralization

After cooling the sample raw materials, we have used proper washing to remove NaOH from the fibers by using nylon strainer and mash fabric. Several washing processes are used for proper washing. In this stage, we have used a little amount of acetic acid for neutralization.

2.5 Pulp preparation

After neutralization, we have used a blender for producing pulp. This is a very important point for paper production, where paper smoothness and fineness are dependent on proper it. Good blending can give good pulp, and good pulp can give the good paper.


Figure 4: Pulp Preparation

2.6 Paper production

There are many processes for paper production. In our project, we have used a conventional paper production process due to our limitations. After getting the suitable pulp, it was placed into the frame which immersed in water. The pulps were mixed with sufficient water on a tub and were spread on frame. Continuous shaking is required for even distribution of the fibers in the frame. After confirming, the even distribution need to bring out of the tub and dry on normal sunlight or air dryer. Both the drying process was applied to observe the quality difference of the drying process. It should be mentioned that after half drying, the padder machine could be used to reduce the uneven thickness and crease for producing a better sheet of paper.

Figure 5: Paper Production (A)

Figure 6: Paper Production (B)

Figure 7: Paper Production (c)

By using Titan Universal Strength Tester machine, tensile strength of each samples were measured and tabulated as below:

Table: Test Results from water hyacinth paper

S.N.	Sample	GSM	Thickness (mm)	Strength (N/m2)
1	Leaf	5.42	0.089	47.46
		13.17	0.132	77.22
2	Stolon	4.65	0.081	22.74
3	Petiole	5.05	0.087	52.22
4	petiole dry	64.34	0.88	244.26
		32.55	0.529	130.57
5	Root	27.13	0.444	343.62
6	whole plant	40.31	0.443	151.21
		65.89	0.53	215.7

3. Results and discussion

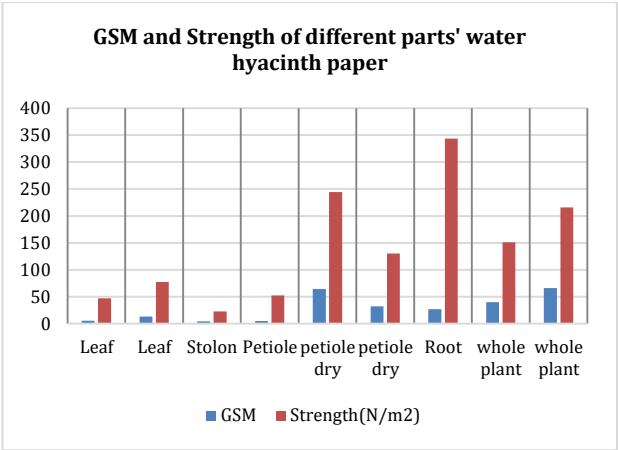

Chart: GSM and Strength of different samples

Different parts of water hyacinth show different paper in case of GSM and strength relations. The relation between GSM and strength is proportional. Higher strength is seen in root and petiole dry at comparatively at lower GSM than the other parts of water hyacinth. Dry petiole shows much better strength than wet petiole. The root shows extraordinary result. The reason behind this the blending are better than other so the pulp is better. Amount of cellulose is present much in petiole than other parts of the water hyacinth.

Figure 8: Color of samples made by different body parts of water hyacinth

Above images also confirms that a water hyacinth plant also can produce different types of colored paper. As no color was added, it confirms the color of the papers are natural and chemical free.

Conclusions

Lignin and Cellulose both can be source of use of this plant in different uses. As a lignocellulosic fiber, paper was possible to produce from this plant and higher strength was observed from paper produced by root and petiole. Dry petiole also shows higher strength also. Further research with this plant can provide more possibilities to produce finer and aristocrat paper with different natural color.

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