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Eco-friendly approach toward preparation of plantable paper like material from organic sugarcane bagasse waste

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ABSTRACT

Present research work focused on sugarcane bagasse powder having potential cellulose source which can be used in pulp and paper industries. Ecological concerns have increased the need for nonwood pulp as a low cost raw material for paper making. This also led to the development of alternative pulping technologies that are eco-friendly. Cellulose pulp from the generated agro based waste is collected from the street vendors and chemically prepared in the laboratory and used in paper making. The optimal cooking time and dose of pulp by moist weight found were 180 minutes & 150 g of pulp per frame, respectively. To improve the quality and the shelf life of paper we incorporated sucrose in the sugarcane pulp. Sucrose acts as a natural preservative. To study the effect of sucrose as preservative we prepared a solution of sucrose and distilled water in 1:4 ratio. The solution is then mixed with sugarcane bagasse in 5:250, 10:250, 15:250 and 20:250 and observed the OD of the mixture on 20th and 27th day. By using this pulp we developed a paper with incorporated artificial seeds within it, so that after use of this paper rather than discarding the paper simply sowing it in garden soil a plant will grow from it and generate a means of eco initiatives. This plant able paper is developed by handmade process without using any harmful chemicals and can be made using everyday use material. Anyone can use this method and make the paper. The paper obtained from this process is found to be of good quality and durable and can be used for preparation of commercial Kraft's of different purposes like greetings card, packaging etc., and can generate new way of a revenue.

Key words : *Cellulose, Pulp, Sugarcane bagasse powder, Eco-friendly, Artificial seeds, etc.*

Introduction

Pulp and paper production is one of the high demand sectors in the world of industrial production. The total global consumption from paper-making was projected to increase from 316 million tons in 1999 and 351 million tons in 2005 to about 425 million tons by 2010 found out as per the studies done by Gracía *et al.,* (2008).

Non-wood fiber is the major sources for the pulp and paper industry in developing countries due to their abundance and cost-effectiveness. These non-wood materials have high potential to be used as alternative choices in many paper grades, including writing and printing papers. Fibrous materials that are discussed include bagasse, seeds, cereal straw, cotton stalks, canola and rice straw. Non-wood plant fibers that are currently used in the paper industry are broadly divided into three groups based on their availability. These are agricultural residues, natural

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growing plants and non-wood crops grown primarily for their fibers.

Agricultural-based paper is a guaranteed way to reduce the stress of paper production on old growth and endangered forests. What's more, some agricultural residue pulps take less time to cook than wood pulps. That means agricultural-based paper uses less energy, less water and fewer chemicals as per the review of Saiprabha Mahale and Goswami-Giri (2015).

There is a growing interest in the use of non-wood such as annual plants and agricultural residues as a raw material for pulp and paper. Non-wood raw materials account for less than 10% of the total pulp and paper production worldwide. Stated by El-Sakhawy, Lönnberg *et al.,* (1996). This is made up of 44% straw, 18% bagasse, 14% reeds, 13% bamboo and 11% others. Non-wood are in some applications alternatives to paper made from wood pulp, like filter paper or tea bags. Nonwood fibers are used for all kinds of paper. Writing and printing grades produced from bleached non-wood fiber are quite common.

After consumption or processing of the sugarcane juice, considerable amounts of sugarcane bagasse are discarded as waste and improper disposable of this waste is again a problem. It leads to environmental imbalance. Hence attempt is made to develop a paper from sugarcane bagasse powder. Our vision is to make up a healthy sustainable future by empowering people with knowledge to live more responsibility. The use of bio degradable materials can be:

- Hygienic to the surrounding living beings.
- Create a solution in the form of biodegradable eco-friendly materials made from plant based agricultural raw materials.
- Easy to use and dispose.
- Easily degrade without causing toxicity or pollution to the environment.
- Can be made from cheaply available biological wastage (sugarcane bagasse, dried straw, etc.).

In another approach we also tried to incorporate artificially coated seeds while preparing the pulp for the paper. Keeping in mind if it could be used a greeting cards and gifted to someone and instead of discarding it, planting in home garden so that someday it might grow into a plant and will remain as a pleasant memories.

Sugarcane bagasse is one of the best filed crop fiber. Sugarcane bagasse, the sugarcane residue after extraction is one of the most available paper making lignocellulosic fiber resources in some developing countries like India. In India 20% of paper are made from sugarcane bagasse Amir Hooman Hemasi *et al.* (2011).

Sugarcane bagasse is one of the best method for production of paper. It can easily be available from sugar factory. For every 10 tons of sugarcane crushed in a sugar factory produces nearly three tones of bagasse Wikipedia pulp.

Table 1. Bagasse compositionof sugarcane bagasse waste is described below. Sarita Candida Rabelo *et al.* (2015).

Composition (%) dry base	Bagasse
Glucose	19.50
Xylose	10.50
Arabinose	1.50
Galactose	0.55
Lignin	9.91
OrganoSolubles	2.70
Reducing sugar	1.85
Uronic Acid	1.91
Ash	1.60
Moisture	50.00
Total hexose	20.04
Total pentose	12.00

Materials and Methods

The fresh samples of agro based sugarcane bagasse waste were collected from GUWAHATI (Fancy Bazar, Bhangarh and Narengi) of Kamrup District of Assam, India in the month of December, 2020.

Then collected organic was brought in the Department of Biotechnology, Assam Down town University in big cartoon boxes. The seeds for incorporation in our paper material were purchased from only for organic store from Amazon.in. The paper making Paper making frame of size:20*30*1.5cm/ 7.87*11.8*0.59 inch was also purchased from Amazon.in. The required chemicals (Distilled water, Dimethyl sulfoxide (DMSO), Sucrose powder, Sodium Alginate, Calcium Chloride, Starch powder) were provided from Assam downtown university biotechnology laboratory.

Raw Material Preparation

The collected organic sugarcane waste was washed with tap water and dried under sun for nearly one

month of time span. Then grinded with the help of grinder to make it into powder material i.e. Sugarcane bagasse powder and stored in air tight container for further use in the development of plant able paper like materials.

Incorporation of Sucrose with Bagasse Powder in Four Different Ratio/Concentration to Check the Turidity for Bacterial Growth, Checking the Od

250 g of sucrose powder was measured and mixed in 1000 ml of distilled water & boiled in how water bath in 60'c for 45 min. Then this liquid was transferred in four different individual conical flask, in four different ratios of sugarcane bagasse powder: sucrose 250 g in 1000 ml of d.H2O: 5 g: 250 ml, 10 g: 250 ml, 15 g: 250 ml, 20 g: 250 ml. Then 1 conical flask extra is taken and poured 5g of sugarcane bagasse powder: 250 ml of d.H2O (i.e., 5 g: 250 ml) without adding sucrose powder, taking it as the control for the experiment. This conical flasks were tightly plugged with cotton and wrapped with aluminium foil for 20 days. After 20 days with the help of colorimeter OD is observed. Then again at 27th day another reading was taken to compare the Optical Density.

Encapsulation of Artificial Seed's

Dropping method was used for encapsulation of seeds. *Capsicum frutescenes* and *Brassica* seeds were added in Sodium Alginate solution (10 g of sodium alginate powder is mixed in 50 ml of distilled water using micro-oven). Then with the help of a dropper seeds were dropped in chilled Calcium Chloride solution (2 molar 11.098 g of calcium chloride powder is mixed in 50 ml of distilled water and kept in refrigerator for few min). Leave the immobilized seeds for 5-10 min to get coated with hydrogel in chilled Calcium Chloride solution. Separate the bead of seeds using tea strainer and store it in freezer for further use.

Preparation of Fibrous Pulp

In a borosil glass beaker pour:

-Distilled water-300 ml
-Sugar cane bagasse powder –150 g (500 g/l)
-Starch powder-50 g/l
-Sucrose powder-5 g

Now the solution is mixed nicely with spatula and cooked for 180 min in 100 ºC temperature with the help of hot plate. After bringing the cooked bagasse pulp slurry in room temperature the pulp was filtered through Strainer filter (0.4 mm mesh) to isolate the uncooked material. The pulp was then squeezed to 20-25% ratio of solid particle.

Preparation of Paper From the Fibrous Pulp with Artificial Seed Incorporated/ Preparation of Plantable Paper

The pulp is then transferred in to a big container. At this point, a filler material is added in this pulp such As chalk powder. These additive will influence the opacity and other qualities of the final product. Sizing is also added at this point. Sizing affects the way the paper will react with various inks. A sizing such as Starch powder (12.5 g) makes the paper resistant to water. This pulp blended ingredients were placed on wooden mesh (sieve) frame Size: 20*30*1.5cm/7.87*11.8*0.59 inch to make a paper sheet, with a thin cloth on it. The artificial seed which was prepared earlier was evenly spread over the pulp.

The sieve is shaken so as to spread the pulp evenly on the cloth. Extra water also drained out in this process with the help of a sponge. The cloth is removed carefully without disturbing its contents. Pressure is then applied from either side to squeeze out excess water from the sheets. This improves the physical properties of the paper and facilitates drying. The sheets are removed after the water is sufficiently removed and the shape of the paper is retained, dried under the sun and after in shade for one week.

Analysing for the Growth of Plant from the Plantable Paper

The plantable paper is torn into small pieces where encapsulated seed are present.The small paper pieces then planted in a small pot dimension: 12*12*6 cm (L*W*H), covering 3 cm nicely with soil collected from the bank of river Brahmaputra. Nicely watered twice a day (early morning and evening) in quantity of about 15+15 ml i.e., 30 ml in total, so that plant would remain well hydrated. Pot was placed in partial sunlight region.

Results and Discussion

Incorporation of Sucrose With Bagasse Powder in Four Different Ratio/Concentration to Check the Turidity for Bacterial Growth, Checking the Od

Data for the different ratio's after the time interval of

20 days were collected with the help of colorimeter at 580 nm and was compared with data collected at the 27th day, given below in the tables, we can conclude that addition of sucrose, can act as preservative.

Fig. 1. Four different ratios of sugar cane bagasse powder: sucrose 250 g in 1000 ml of d.H_2O:- 5g : 250 ml, 10 g: 250 ml, 15 g: 250 ml, 20 g: 250 ml and one control without sucrose powder 5 g: 250 ml of d.H_2O.

Table 2. Measurement of OD after 20 days.

Sample Ratio's	Optical Density (ABSORBANCE:570nm)
CONTROL	0.03
R1(5g: 250 ml)	0.05
R2(10g: 250 ml)	0.06
R3(15g: 250 ml)	0.10
R4(20g: 250 ml	0.11

Table 3. Measurement of OD on 27th day.

SAMPLE RATIO'S (ABSORBANCE:570nm)	OPTICAL DENSITY
CONTROL	0.04
R1(5g: 250 ml)	0.05
R2(10g: 250 ml)	0.06
R3(15g: 250 ml)	0.10
R4(20g: 250 ml)	0.11

Encapsulation of Artificial Seed's

In Hydrated condition, using sodium-alginate seed embryos were coated and dropped in calcium chloride solution and for the presence of calcium in $CaCl_2$ which is a multivalent cation it forms into a hydrogel coating composition due to formation of co-ionic bridges.

Preparation of Paper from the Fibrous Pulp with Artificial Seed Incorporated/ Preparation of Plant Able Paper Material

Pulping process

Usually the cooking of pulp is intended to do delignification. The lignin removal depends not only on the decay of the ether bonds in lignin macromolecules, but also on the capability of the aqueous solvent solution to dissolve lignin fragments. The optimal cooking and dose of pulp by moist weight found were 180 min and 150 g of pulp per frame.

Fig. 2. Artificial seed preserved for further use in end of the project.

180 minutes of the chemical pulping time gave paper with fine structure and no residues of hard fibers of sugar cane bagasse waste. When considering the turbidity of the spent liquor after the pulping

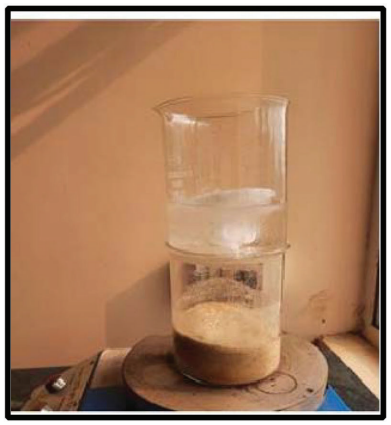

Fig. 3. Pulping process: Using hot plate at 100ºC for boiling the raw ingredients required for the paper making.

process, it was found that the turbidity increase with cooking time due to the precipitation of lignin on the surfaces of the fibers, in agreement with Xu *et al.* (2007). And Laftah and Rahaman (2015). Thus 180 min was selected as the optimal alkaline cooking time.

Fig. 4. 7.8 x 11.8" Wooden Paper Making Papermaking Mould Frame Screen Tool.

Preparation of the plantable paper material

Paper poducts are categorized by their grammage, which is the mass per unit area. The grammage of the handmade paper can be varied by increasing or decreasing the amount of pulp used for one sheet. The weight and thickness of paper sample made from sugar cane bagasse powder are shown in Figure 5 (B). The pulp dose of 150 g per sheet was selected for the development of the plant able paper material due to the incorporation of artificial seeds with keeping in mind to turn this material into commercial craft (i.e., to be used in preparation of greeting card and wedding cards).

Fig. 5. Due to cooking time of 180 min of texture of the paper is fine with no residues of sugarcane hard fibers and dose of Pulp is 150 g.

Checking for the Growth of Plant from the Plantable Paper

Sheet Developed

Good quality of seeds were bought from ONLY FOR ORGANIC store and coated with hydrogel, i.e. artificial seed coat to prevent any kind of desiccation to the seeds.

Fig. 6. Readymade available good quality seeds were used for encapsulation.

Without the use of any bio fertilizer, the growth of plant shoot have seen within a period of few days after plantation. The growth of plant is monitored and described below in Table 4, with proper visual report.

Conclusion

The incorporation of sucrose powder added might be effective as a direct nutrient source to the soil microbes when discarded and enhances the biodegradation process of the material.

The result overall demonstrate that plantable paper developed with incorporated seeds made from the organic sugar cane bagasse can be used for the preparation of commercial paper crafts artefacts such as greeting cards, etc. Such kind of eco initiatives should be discovered so that it may generate revenue and hand in hand keeping environmental awareness.

Rising demands for paper and environmental concerns have enhanced the need for non-wood pulp as a low cost raw material for papermaking. This has also led to the developing of alternative pulping technologies that are environmentally friendly. Agricultural waste have tremendous po-

Table 4. Growth report of plantlets from the plantable paper

Number of days	Characteristic of the paper material used as plantable
Day 1	Plantable paper is cut into pieces and place on the soil of pot. After hydrating, the pot was placed in partial sunlight area.
Day 2	No growth were visible
Day 3	No growths were visible
Day 4	Small shoots were developed and touching the soil in the side region
Day 5	Shoots developed from the mid area properly
Day 6	Plantlets grew up nicely visible
Day 9	Height increases to1cm
Day 12	Height increases to 1.5cm
Day 14	Height increases to 2.0cm
Day 15	Height increases to 2.3cm. Chilli and mustard plant are separated and grown in different pot.
Day 19	Height increases to 3.0cm and leaves are developed
Day 22	Height increases to 3.5cm
Day 25	**Height increases to 4.0cm**

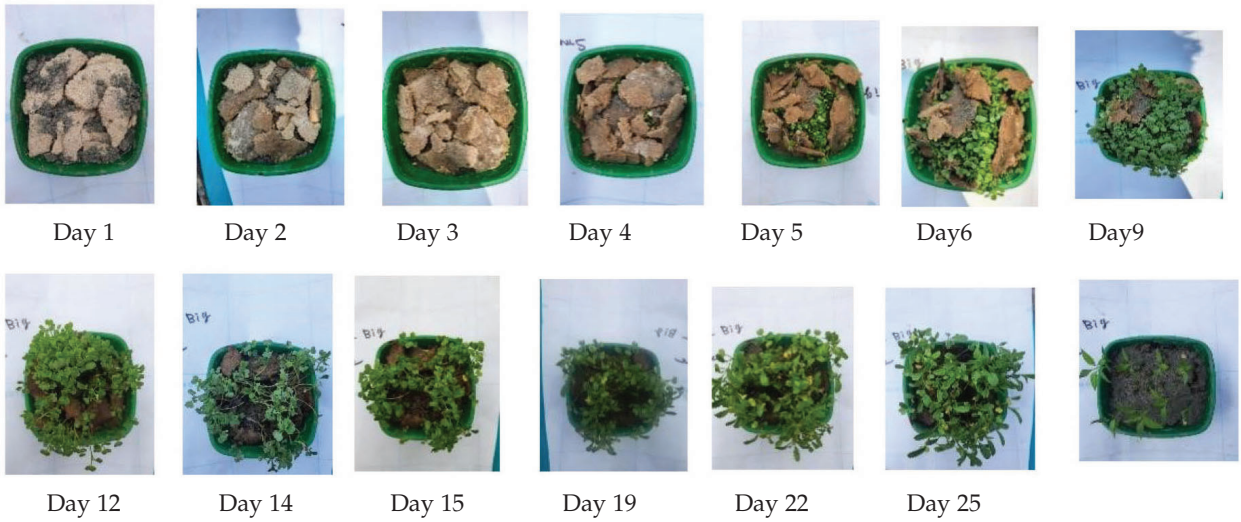

Fig. 7. Time interval for the growth of shoots visual report.

tential as an alternative resource for the pulp manufacturing companies due to the fact that, they are available and readily regenerated.

Therefore, there is a need for identifying more non-wood materials as sugarcane bagasse, mango seed coat, pineapple leaf, etc., with high potential for pulp and paper production. From the above research work done concludes that the paper prepared from sugarcane waste powder pulp have potential may be completely or partly can replace cellulose papers which show the enhanced or similar physical properties.

Conflict of Interest

Authors declares that they have no conflict of interest.

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