

Pulp and Paper Making by using Waste Banana Stem

Intezar Hussain¹ and Omer Mukhtar Tarar²

In today's modern world, use of paper and boards has increased massively. Traditionally, paper is manufactured from cellulosic materials. The use of forest sourced fibre to produce paper has increased greatly. It is now widely accepted that alternative must be found. Paper making industries are faced with significant environmental and raw material availability challenges. In this perspective, it is looking for alternative raw materials. One of the materials found to be capable is banana pseudo stem waste. This paper presents a proposal for use of banana pseudo stem. After banana harvesting, the pseudo stems are cut and left on the ground, this waste is then causes emission of harmful gases (CO₂). In order to add value to banana plantation, the pseudo stem could be processed into valuable products (Paper). Waste Banana stem is a very good source of cellulose. It contains 39.12 % cellulose and 11.34% lignin. Cellulose can be easily separated from lignin without using toxic chemical during process. A huge mass residue is produced from banana plantation, all of which goes waste due to non-availability of suitable technology for its commercial utilization. Due to large availability of banana stem waste in the country, it is important to implement Cleaner Production and Green Chemical Technology to utilize waste banana pseudo stem into useful products (paper). Pakistan is rich in natural resources and can play major role in reduction of global warming, climate issues. Also the utilization of banana waste into useful products (paper) will strengthen the Pakistan economy.

Field of Research: Chemical Engineering

Keywords: Banana Pseudo-Stem; Cleaner Production; Environmental Friendly Paper Making; Agricultural Waste; Re-Use

1. Introduction

The conventional paper is derived from wood that is the paper industry is mainly depending upon forest resources, as a result deforestation take place to meet the availability of raw material for paper making industry. It is broadly accepted that the deforestation causes environmental pollutions and global warming. In recent year, people have placed a high emphasis on forest preservation and rational use of forestry and agriculture residues (Shiyu Fu Li et al. 2010). Hence, due to harmful effects of deforestation, it is important to search for alternative cellulose containing resources. Studies have shown that the production process of paper from non-wood fibre is significantly less expensive than from wood fibre (Weston, 1996).

In the fields of banana, when fruits are harvesting, the banana stem are cut off and let it down nearby fields because each banana plant cannot be used for the next harvest. There are three reason of cutting of stems, the very first reason is that

Intezar Hussain¹, Undergraduate Student, Chemical Engineering Department, Dawood University of Engineering and Technology, Karachi, Pakistan. Email: enqr.intezar@yahoo.com
Omer Mukhtar Tarar², Senior Scientific Officer, Food and Marine Resources Research Center, PCSIR Laboratories Complex Karachi, Pakistan.

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Banana stems are cut off when fruits are harvested, the second reason of cutting off banana stem is due to diseases (that is because of attack of fungi which are grown in result of waste banana stem) and female banana stems are also cut off after the maturity of male plant. So that a massive organic waste is produced because the banana stems cannot be used as an animal feed or other alternative. The waste then causes emission of toxic gases including CO₂ and also gives growth to the harmful fungi which attack on remaining banana trees.

It is estimated that, Banana is cultivated on 34.9 thousand hectares in Pakistan. More than 90% area under banana falls in Sind province, contributing 80% of the total production in the country. In Sind, Thatta and Khairpur districts occupy 50% of the banana cultivated area and contribute 52% of the total banana produced in Sind. The availability of the large scale of banana stem waste in the country and shortage of raw materials for producing pulp and paper, it makes sense to use waste banana stem for paper making.

The paper is organized as follows: Section 2 deals with materials and methods and section 3 focuses on results and discussion. Section 4 provides conclusion.

2. Material and Methods

The raw material was the entire length banana waste stem. It was collected from a banana field in Tando (Sindh, Pakistan). The stem consists of layers which can be easily separated by hands. The stem was chopped in small pieces of about 3-5cm. It was then dried at 45°C for 3 days.

2.1 Chemical Analysis

The dried sample was first passed to Soxhlet extraction with mixture of ethanol and toluene (1:2 v/v) for 5hr. The holocellulose, α -cellulose and lignin were determined by following methods,

Lignin:

TAPPI Method (T13 05-54)

Holocellulose:

L.E Wise et.al chloride holocellulose, Paper Trade journal 122(1): 35-43 (1946).

HD Erixson same aspects of method in determined of cellulose in wood, TAPPI method T45 710-19(1962).

α -Cellulose:

K.M Siddiqui relationship between cell wall morphology.

The holocellulose contents is determined by mixing 0.5gm of dried sample in mixture of sodium hydroxide and nitric acid (w/v) and is boiled for 1hr at 80°C. It is then treated with sodium hypochlorite under reflux condition during five cycle of 1hr at a temperature of 80°C. The sample was then filtered with nitric acid and hot distilled water.

The important chemical composition which concern with paper making industry such as, holocellulose, cellulose and lignin contents of banana stem were determined in chemical analysis.

2.2 Pulp and Paper Making

The pulp and paper making process is carried out in following way, Fig.1 *Paper Making Processing Steps* shows the Paper making process.

Raw Material Collection:

Banana stem waste, which is thrown away by farmers after harvesting of fruits, is obtained as raw material.

Chopping:

The stems are chopped into small pieces of 3-4 inch in size.

Digestion:

The material is soaked in 2-5% NaOH for appropriate period. The alkali loosens the ligno-cellulosic bonds, thereby softening the material.

Washing:

The softened material is washed with water to remove the black liquor of sodium lignite and unused alkali.

Beating:

The washed material is then subjected to beating. Beating is required for a getting good quality pulp, depending upon the quality of boards/paper to be produced.

Storage:

After beating, the desired pulp is produced which is then stored in storage tanks.

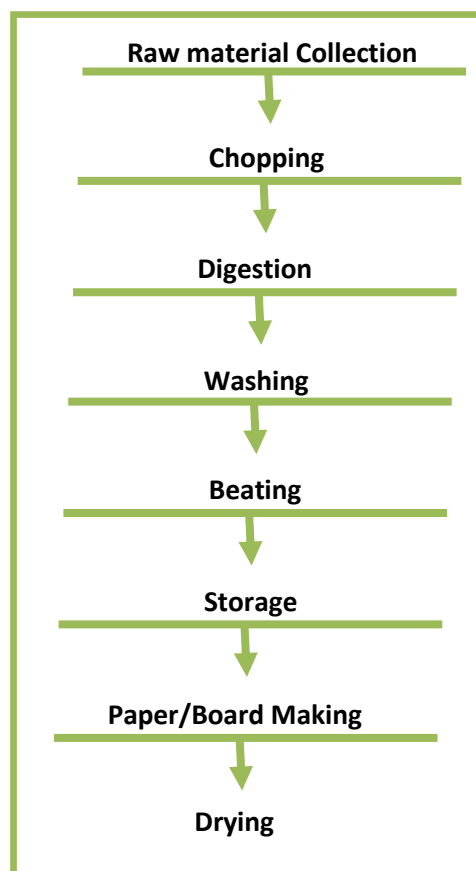
Paper making:

Paper is then making from the pulp of desired quality.

Drying:

The wet boards/papers are then allowed to dry.

Fig.1: Paper Making Processing Steps



3. Result and Discussion

The paper industry is mainly concern with cellulose and lignin contents. The cellulose is desired and lignin is undesired content. By comparing with other sources, banana stem consists of very low content of lignin. The lignin content cementing the cellulose with each other and it causes the hardness of the stem. In paper industry it is important to separate lignin from cellulose, by using other traditional sources like wood required highly toxic chemicals for the separation of lignin from cellulose but in case of banana stem there is a very low content of lignin is present which can be easily removed and we don't need to use toxic chemicals additives during processing. So in this way the paper making from banana stem is environmental friendly.

The digestion processes is carried out at low temperature and temperature which helps to consume low energy. The chemical composition is shown in Table.1 Chemical Composition.

Table 1: Chemical Composition

S. No	Constituents	Percentage
1.	Holocellulose	59.4
2.	Cellulose	39.12
3.	Lignin	11.34

4. Conclusion

The study shows that Banana stem which is currently wasted after harvesting fruits is good cellulosic source and contains very low content of lignin. This waste is also causes environmental pollution. The chemical composition of banana stem shows that banana stems which wasted, is a good raw material for Pulp and paper making industry. The pulping of banana tree residue with NaOH requires minimum heating conditions. Thus the utilization of waste banana stem helps us to save our forest and decrease environmental issues.

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