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A REVIEW PAPER ON DESIGN AND DEVELOPMENT OF BANANA FIBER EXTRACTION MACHINE

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ABSTRACT
The present paper is aimed at to design and develop an automated process to extract high quality natural fibers from the banana pseudo stems. Manual extraction of banana fiber produces goo quality of fiber but it much time consuming. Labor expense is quite high and output is quite low. Hence efficient extraction of banana fiber can only be possible through mechanization. Now day's machines exist for extracting banana fiber but are manually operated and cannot be applied for mass production. The other main disadvantages of existing machine are impurities present in rolled fiber. The efficiency of existing machine is average. It consumes time & the process is not safe. So it cannot be recommended for mass production. So our aim is to develop complete automated machine suitable for mass production and yields good quality of fiber to increase the production.

KEYWORDS: Banana fiber, design of fiber extraction machine, analysis, spinning technology.

INTRODUCTION
BANANA FIBER –
Banana fiber is environmentally friendly like jute fiber. It has large export demand from many countries like Japan, Australia, Germany and many. Fiber can be obtained from whole banana plant. After the fruit is obtained, the plant is thrown away giving rise to increase in waste. The proper disposal of this plant is another problem. By using a good fiber extractor machine, a large amount of fiber can be obtained which will give rise to additional income. Banana fiber is a best fiber with relatively good mechanical properties due to its high alpha cellulose and low lignin percentage.

Applications-
- Banana fiber has great potentialities for paper making specially demand of handmade papers.
- Even in some countries it is used for making currency paper.
- It is used for making rope, mats and other composite materials
- Banana fiber has recognized for apparels and home furnishings.
- Composite material of banana fiber is used in building boards and fire resistance boards
- Polypropylene reinforced with banana fiber is used by automobile companies for making under floor protection panels in luxurious cars like Mercedes
- Banana fiber mostly used in making handicrafts and home decorative

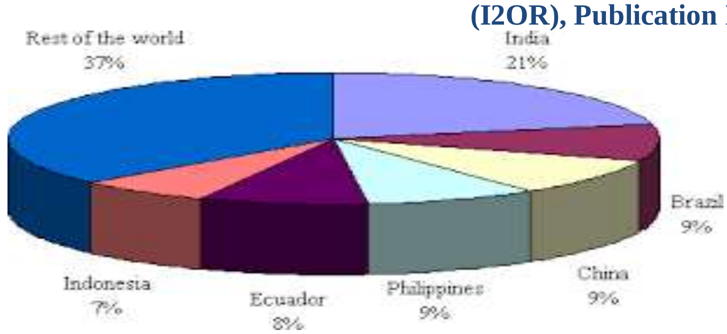

Fig.1 world banana production

Table 1: Physical/Chemical and Tensile Properties of some lignocellulosic fibers used for biocomposites. [Adopted from Ref. 3, 8, 10].

Fiber	Dimensions L(mm)/D(μm)	α-Cellulose (%)	Lignin (%)	Young´s Modulus (GPa)	Ultimate Tensile Strength (MPa)	Elongation at Break (%)
Sugarcane Bagasse	10-300/10-34	32-44	19-24	17.9[a]-27.1	222	1.1
Banana	300-900 /12-30	60-65	5-10	27-32	700-800	2.5-3.7
Jute	120/25-30	59-71	11.8-12.9	10-30	400-800	1.5-1.8
Ramie	900-1200 / 20-80	80-85	0.5	44	500-870	1.2
Curauá Wet	35/7-10	70.7-73.6	7.5-11.1	30-80[b] 10.5	1250-3000[b] 439-495 (MOR)[c]	4.5-6[b] 1.3
Curauá Dry				27.1 34-96[d]	117 (MOR)[c] /495 87-310[d]	1.3-3.2 4-4.9[d]
Sisal	900/8-50	60-67	8-12	17-22	530-630	3.64-5.12
Coir	20-150/10-50	43.77	45	6	220	23.9-51.4
Luffa-cylíndrica	25-60 (Diameter)	62	11.2	-	-	-

a – Calculated; b - Diameter: 30-60m; Test length- 20mm and Strain rate-5mm/min;
c- MOR: Modulus of Rupture. d – Diameter range 26-64 μm

Fig-2 physical and chemical properties of fibers

EXTRACTION METHOD

MANUAL METHOD

Banana fiber can be obtained from waste stalk, leaf and roots of banana plant. Generally abundant of banana fiber is obtained from surface near to the outer sheath of stem. It can be peeled-off easily in ribbons of strips of 5-10 cm wide and 2-5 mm thick along the entire length of the sheath. The undressing process is known as Tuxying and the ribbons are called as Tuxies**.**

2.1.1 Bacnis Process

It is the simple stripping process in which trunks are pulled apart and sheath is undressed. The fiber is obtained by removing pulpy and pulling away the ribbons (tuxy)

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2.1.2 Loenit Process

In this process a knife or any sharp pointed tool is used for obtaining ribbons. Ribbons are obtained from one sheath at a time. 20-25 kg of fiber is dried, cleaned and bundled.

2.2 CHEMICAL EXTRACTION

For chemical extraction, alkali treatment is used. The alkali NaOH reduces roughness of fiber and good quality of fiber is obtained. In addition, sulfuric acid, hydrogen peroxide, protease, pectinase and sodium citrate were used.

Fiber-OH + NaOH -------Fiber-O-Na++ H2O

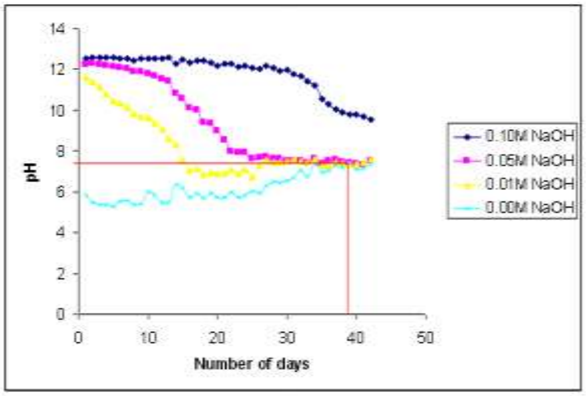

Figure 1: Plot of pH against number of days

Fig. 3 Plot pH against no of days

Thus main disadvantage of chemical extraction is time period taken in the whole process. It can be seen from above graph to produce good quality fiber; chemical extraction takes 35-40 days. The process is costly. There is lot of wastage in the process.

MECHANICAL EXTRACTION -

It is simple machine consisting of single roller which rolls on fixed support. The roller is provided with horizontal stainless steel blades with blunt edges. Generally, 27 blades are used. 1hp motor is used to provide input power to machine. The machine reduces labor work and increases fiber production by 20-25 times as compared to manual process. In this process, cut stems of banana plants of 100-200 cm in length are crushed between two drum rollers. Due to crushing the pulpy part is removed and fiber is obtained.

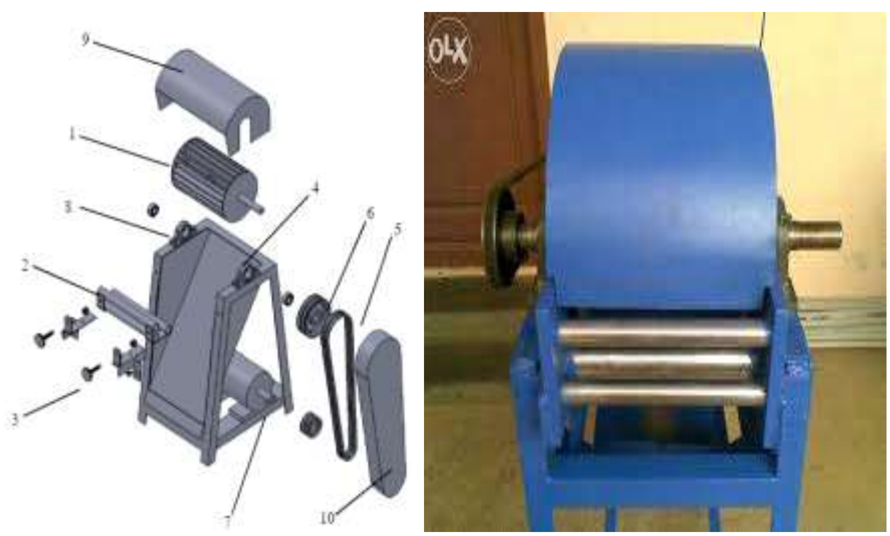

Fig 4 exploded view of existing machine

PROBLEM IDENTIFICATION

- Certain care is needed to avoid damage.
- Impurities in the rolled fibers such as Pigments, broken fibers, knots.
- The manual extraction of banana fibers was time consuming, and caused damage to the fiber.
- This type of technique cannot be recommended for mass production.
- Fibers produced are not of uniform size.

- In addition, there is a safety issue. It is reported that many accidents have happened in past
- Time consuming process.

PROBLEM SORTING

While designing the machine, the most important factor affecting the quality of fiber are clearance between two roller ,speed of roller, and feeding position. Change in these factors causes change in quality of fiber. Superior quality of fiber is one which contains no pulpy matter or pigments or knots. They are uniform in size and are straight.

For our design, clearance of 1mm, drum speed of 700 rpm and feed position of 180 degree are suitable. Instead of single crushing roller, we are providing dual crushing roller for complete removal of pulpy material and knots. The average force required for extraction of fiber is 17.6 kgF.

By providing hopper and conveyor, we can automate the process. This will give rise to increase in production and reduction in time required. Due to hopper, there will be complete utilization of machine and it will reduce human work.

CONCEPTUAL DESIGN

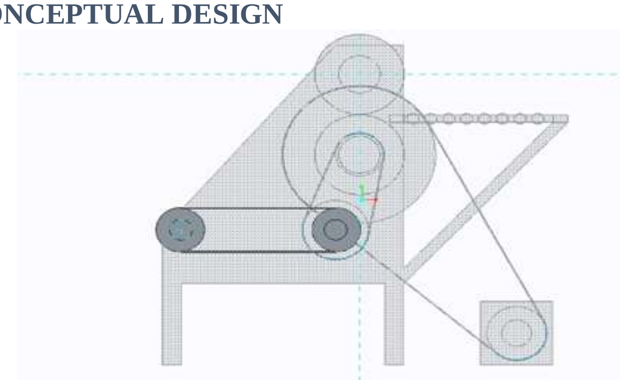

Fig 5(a) side view

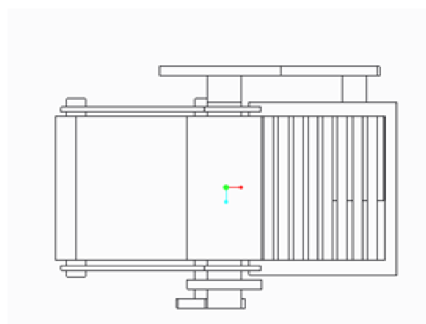

Fig. 5(b) top view

- It will reduce time required
- It will reduce workers effort
- Rate of production is very high
- This method is suitable for mass production
- Quality of fiber is improved

SELECTION AND DESIGNING -

Roller – Roller is the most important element in this machine. It applies necessary squeezing force on pseudo stem of banana separating the pulp, leaving only the fibre. Type of the roller used mainly affect the quality of fibre.
When compared extraction fiber unit, the plain roller could separate a good texture of banana leaf sheath. While saw tooth bar type made damage to the texture. So in our model we are going to use plane rollers.

Fig.6 (a) Roller with saw tooth

Fig.6 (b) Rasp bar roller

Fig.7 (a) Good Quality Fiber *Fig.7 (b) Bad Quality Fiber*

Fig.8 Fiber Quality

The average force required is 177 Kgf
Factor of safety =15
$F_c = mr\omega^2 = 177*15$
N = 700 rpm; ω= 73.3rad/s; m=density*volume=$1767.15d^2$
Diameter = 82 mm
Thus solid roller of 82 mm is required, but hollow roller is recommended. So keeping torque constant & inner diameter 80% of outer diameter we get
$Ds^3 = (Do^4 - Di^4)/Do$
Outer diameter = 140mm
Inner diameter = 120mm
T = F*R = 172.6*.070 = 12.39 Nm

Fig 8 Rollers

Two plane rollers of mild steel 140mm in diameter connected by a gear will be used.

6.2 Power required-

P= $(2\pi NT)/60$
= 949.28watt
= 1.27Hp

6.3 Belt drive –

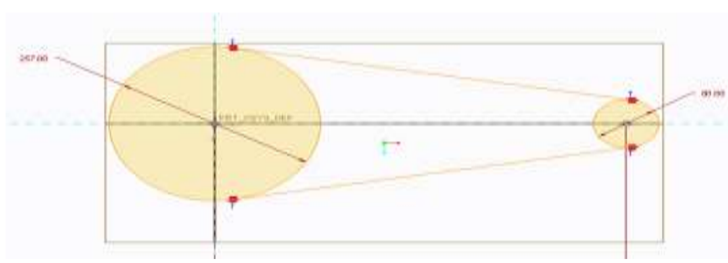

Fig 9 Belt drive

N1= 1420 RPM (MOTOR RPM)
N2= 700 RPM (ROLLER)
If we consider pulley of motor to be D1=50 mm
N1D1=N2D2 D2 =100mm

Minimum Centre distance=3.5*larger dia
Maximum centre distance = 7500mm
C.d.= 1000 mm
Angle of contact =3.04 rad
V = 3.67 m/s
THICKNESS= 0.02D2 = 5.14mm

6.4 Belt drive and pulley (2) –
N3 = 700 rpm N4 =350rpm
D3 = 80mm
N3D3 =N4D4
Thus
D4 = 160mm

6.5 Feeder-

Fig 10 feeder

An automatic guiding feeder is used made up of 8 small horizontal guiding roller
Length of feeder =600 mm
Diameter of roller= 40 mm
Space between roller =40mm

Height of machine from ground- For the ease and comfort of operator, the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level. Enough clearance should be provided from ground for cleaning purpose.

CONCLUSION

The new banana fiber extraction machine can be designed with higher efficiency. This machine will reduce manual work and is suitable for mass production. Compact structure and easy disassembling will be another advantage. The problem of impurities and knots can be solved with this kind of design. The factors affecting quality of fiber are roller speed; feed angle and clearance also affect the production quantity of fiber. By choosing these factors, correctly quality and production of fiber can be increased. By the application automatic feeder and conveyor time and effort can be saved.

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