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Fiber Yield and its Properties Study on Dhaincha Plant Using Different Fermentation Methods

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Abstract

A study was conducted on Dhaincha (Sesbaniaaculeata) plant at the workshop of Farm Power and Machinery Department, Bangladesh Agricultural University, Mymensingh, Bangladesh. The main objective of the study was to study of the fiber yield and its properties on dhaincha plant. Fermentation, mechanical extraction method (Scraping for leaf fiber) was conducted to extracted fiber from plant. The fiber properties like tensile strength, % elongation at break and diameter of fiber decreased with the increase of period of different fermentation methods. Dhaincha plant contained, average 3.74% fiber (green wet basis) and 5.83% (dry stick basis); average 63.81% stick; fiber-wood ratio was 0.006; and fiber yield/plant 12.26 gm. The estimated fiber production of Dhaincha was 1900 kg/ha.

Keywords: Dhaincha, fiber, extraction, fermentation, yield

INTRODUCTION

Three Sesbania species viz. S. bispinosa (Jacq.) W. Wight [former S. aculeate(Wild.) Poir.], S. cannabina (Retz.) Poir. and S. sesban (L.) Merr., are commonly known as “dhaincha” in Bangladesh (Prain, 1903; Sarwar et al.,

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2015). Dhaincha is an ideal green manure crop; to lesser extents they are grown foranimal feed and fodder, ground cover, providing wood, firewood and other usesin traditional agro-forestry systems. Itis generally cultivated forits nutritivevalue to soil. It is cultivatedin monsoon season almost throughout Bangladesh and grows well in loamy, clayey, black and sandy soils. It is an ideal greenmanure crop as it is quick-growing, succulent, and easily decomposable with low moisturerequirements and producesmaximumamount of organic matter and nitrogen inthe soil1. Its seeds and fiber have beenstudied to yield galactomannans, lignin sand cellulose (Mazumdar *et. al.*, 1973, Farooqi *et. al*, 1972, M.N. Islam *et. al*, 2006).Normally Dhaincha is used as cooking fuel and as nitrogen fixing plant in the soil. But it has thick bark which has good quality as jute fiber and the colour is silver like and has tremendous prospect to produce textiles goodsand cloth for shirt and saries.The dhaincha fibers are harsh, coarse and shiny in appearance but lack elasticity (Singh and Rani, 2014). Extracted fiber is suitable for nonwoven fabric and it is used for making fish net and rope, carpets, sackcloth, sailcloth and cordages, paper pulp (Jahan et al., 2009; Orwa et al., 2009; Singh and Rani, 2013).

Different major fiber producing plants are available in our country with their commercial importance. Besides that fiber plants, there are many minor fiber crops present which are not used for producing fiber. So, it is needed to be thoroughly searched out. The main objective of this work was to study of the fiber yield and its properties on dhaincha plant.

MATERIALS AND METHODS

The study was conducted at the workshop of Farm Power and Machinery Department, Bangladesh Agricultural University, Mymensingh, Bangladesh. The raw material, Dhainchaplants (Sesbania aculeate) were collected for extracting fiber from different places.The unnecessary portion was separated by cutting then the weight of the plants was taken before they are processed through the fermenter. After weighed the samples were binding tightly by using plastic rope ((Fig.1). A specific identifier was added with the rope for identification of different samples. The samples were taken for fermentation with four methods:i)aerobic fermentation ii) anaerobic fermentation iii) fermentation with urea and iv) fermentation with CaO. The fermenter was filled up by water. The amount of water is depends on the amount of samples which need to ferment. Then the samples were submerged under water (for anaerobic fermentation) or kept floating on water (for aerobic fermentation). Dhaincha's fiber is attached with its stem. The fiber is needed to separate from the stem for further using. There are different methods available for

extracting the bast fiber (Fig. 2). Stripping is one of them.Stripping is the process of removing the fibers from the stalk after the completion of retting. Extracted fibers were washed in clean water (Fig. 3). Removed all the unnecessary parts from fiber, because this portion decrease the demand and price of fiber in market. Since, the extracted fiber contained some moisture, so, the fiber is needed to squeeze by hand for removing this moisture. After squeezing excess water the fibers were spread on the railing for sun drying for 2-3 days.

Fig. 1: Binding the sample with different identifier before retting

Fig. 2: Extracting stem fiber from Dhaincha plant

Fig. 3: Cleaning the fiber after retting

Moisture content determination of dried fiber and stick

After drying and before weighing all the extracted dried fiber and dried stick were needed to measure its moisture contents. That is why; the extracted fiber and stick were dried by using oven dry method. By this process the moisture was measured content of extracted dry fiber and stick for finding the actual percentages of fiber and stick.

The moisture content can be calculated simply, as follows:

$$\text{Moisture Content } (\%) = \frac{\text{Initial weight} - \text{ Oven dry weight}}{\text{Oven dry weight}} x100 \dots\dots\dots\dots\dots\dots (i)$$

Determination of percentages of fiber and stick:

Fiber percentage is considered as an essential pre-requisite in breeding programme. It is also assumed to be an index offiber yielding capacity of a particular variety.

Different methods are followed to find out the fiberpercentage of jute and allied fibers.

Fiberpercentage on green weight basis

In this method, stems along with total foliage are weighed just after harvest and then ratted for fiber extraction. Then, percentage of dry fiber is calculated on the basis of green weight.

$$\text{Fiber \%} = \frac{\text{Weight of dryfiber after extraction (gms)}}{\text{Weight of stem along with total foliage (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (ii)$$

$$\text{Fiber \%} = \frac{\text{Weight of drystick after extraction (gms)}}{\text{Weight of stem along with total foliage (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (iii)$$

This method gives us a ready-made idea about the possible yield of fiber of a particular area before extraction.

Fiber percentage on stripped weight basis

In this method, leaves and branches are stripped off just after harvest and weighed immediately. The stripped plants after weighing are sent for retting. The fiber % is calculated on the basis of stripped weight.

$$\text{Fiber \%} = \frac{\text{Weight of sun dryfiber (gms)}}{\text{Weight of stripped stem (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (iv)$$

$$\text{Fiber \%} = \frac{\text{Weight of sun drystick (gms)}}{\text{Weight of stripped stem (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (v)$$

Fiber percentage on dry weight basis

In this method, fiber percentage is calculated on the basis of total dry weight of fiber and stick after extraction.

$$\text{Fiber \%} = \frac{\text{Weight of sun dryfiber (gms)}}{\text{Weight of (strick + fiber) (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (vi)$$

$$\text{Fiber \%} = \frac{\text{Weight of sun dried stick (gms)}}{\text{Weight of (strick + fiber) (gms)}} x100 \dots\dots\dots\dots\dots\dots\dots\dots (vii)$$

Percent Elongation at breaking Test

Elongation recorded at the moment of rupture of the specimen, often expressed as a percentage of the original length. It corresponds to the breaking or maximum load.

1. Laid the fiber sample across the table of machine
2. Measure the length of fiber samples to be tested
3. Using two pair of needle-nosed pliers, grasp the sample at each end. Hold one end of the sample at "0" on the yard stick. *Slowly* stretch

the other end of the sample as far as it will stretch, until the sample breaks.

4. Using the formula below, calculated percent elongation at the point of breaking

$$\frac{\text{Elongation at break}}{\text{Original length}}\ x100 = percent \text{ elongation at break} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (viii)$$

Fiber dimension Test

Micro hardness tester machine (HMV-2 series) was used to measure the diameter of the fiber. The measuring range of this machine was .01 µm -500 µm.

RESULT AND DISCUSSION

Dhainchaplants were collected from different fields for measuring the various parameters which are shown in Table 1. The result of Table-1 shows that Dhaincha plant contained, average 3.74% fiber (green wet basis) and 5.83% (dry stick basis); average 63.81% stick; fiber-wood ratio was 0.006; and fiber yield/plant 12.26 gm.The estimated fiber production of Dhaincha was 1900 kg/ha.

Table1: Various parameters for Dhaincha

Sample No.	Length of plant, (cm)	Surface Area of plant, (cm^2)	Green wt. before retting, (gm)	stick wt. (gm)	% stick	extracted fiber/plant (gm)	Wt. Loss, (gm)	% Loss	%fiber (wet basis)	%fiber (dry stick basis)	fiber-Wood ratio
1	487.68	1862.69	500.00	318.60	63.72	19.45	161.95	32.39	3.89	5.75	0.06
2	457.20	1338.20	300.00	184.87	61.62	10.24	104.89	34.96	3.41	5.54	0.06
3	472.44	1744.32	500.00	312.50	62.50	18.50	169.00	33.80	3.70	5.92	0.06
4	441.96	1237.32	240.00	152.40	63.58	8.19	79.21	33.00	3.41	5.37	0.05
5	441.96	1124.63	250.00	159.20	63.68	9.57	81.23	32.49	3.83	6.01	0.06
6	457.20	1454.82	325.00	216.30	66.55	12.80	95.90	29.51	3.94	5.92	0.06
7	441.96	1237.32	260.00	170.20	65.46	10.62	79.18	30.45	4.08	6.24	0.06
8	441.96	1068.30	175.00	112.38	64.22	7.38	55.24	31.57	4.22	6.57	0.07
9	396.24	1008.51	160.00	98.60	61.62	5.46	55.94	34.96	3.41	5.54	0.06
11	445.01	1204.41	225.00	145.50	65.25	7.36	70.14	31.45	3.30	5.06	0.05
12	469.39	1647.82	435.00	284.60	65.43	17.30	133.10	30.60	3.98	6.08	0.06
14	481.58	1789.31	540.00	335.20	62.07	20.20	184.60	34.19	3.74	6.03	0.06
Mean	**452.88**	**1393.14**	**325.67**	**207.55**	**63.81**	**12.26**	**105.86**	**32.45**	**3.74**	**5.83**	**0.06**
Standard Deviation	**24.26**	**298.81**	**133.96**	**84.04**	**1.64**	**5.26**	**45.26**	**1.80**	**0.30**	**0.41**	**0.00**

The obtained fibers of different samples were shown in Fig. 4.

Fig. 4: Obtained fiber of Dhaincha

Effect of fermentation methods on various fibre parameters of dhaincha plant

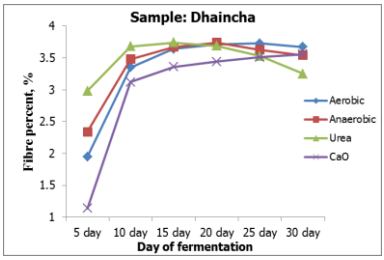

Fig. 5: Effect on percent fiber of Dhaincha plant for fermentation methods

Above Fig. 5 showed that, for Dhaincha plant, maximum 3.73% fiber was found after 25 days of aerobic fermentation; 3.74%fibre after 20 days of anaerobic fermentation; 3.74%fibre after 15 days of fermentation with urea and 3.56%fibre after 30 days of fermentation with CaO.

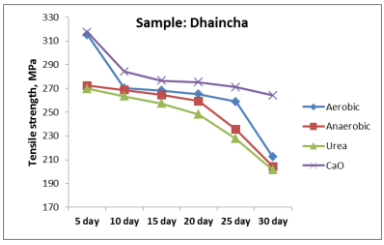

Fig. 6: Effect on fibre strength of Dhainchafibre for different treatments

Above Fig. 6 showed that, for Dhaincha plant, 258.96 MPa strength was found after 25 days of aerobic fermentation; 2.59 MPa strength after 20 days of anaerobic fermentation; 257.24 MPa strength after 15 days of fermentation with urea and 2.64 MPa strength after 30 days of fermentation with CaO.

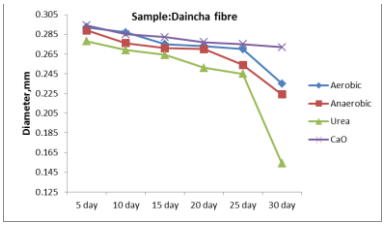

Fig. 7: Effect on fibre thickness of Dhainchafibre for different treatments

Above Fig. 7 showed that, for Dhaincha plant, 0.2699 mm diameter was found after 25 days of aerobic fermentation; 0.27 mm diameter after 20 days of anaerobic fermentation; 0.264 mm diameter after 15 days of fermentation with urea and 0.272 mm diameter after 30 days of fermentation with CaO.

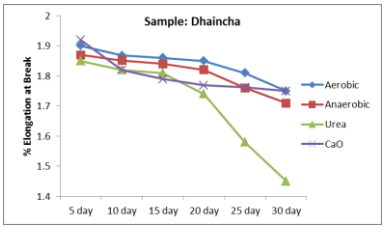

Fig. 8: Effect on elongation break of Dhainchafibre for different treatments

Above Fig. 8 showed that, for Dhaincha plant, 1.81% elongation break was found after 25 days of aerobic fermentation; 1.82 % elongation break after 20 days of anaerobic fermentation; 1.81 % elongation break after 15 days of fermentation with urea and 1.76 % elongation break after 30 days of fermentation with CaO.

Above figures showed that, tensile strength,% elongation at break and diameter of fiber decreased with the increase of period of different fermentation methods.

CONCLUSION

It can be made from this study that the fiber properties like tensile strength, % elongation at break and diameter of fiber decreased with the increase of period of different fermentation methods. Dhaincha plant contained, average 3.74% fiber (green wet basis) and 5.83% (dry stick basis); average 63.81% stick; fiber-wood ratio was 0.006; and fiber yield/plant 12.26 gm. The estimated fiber production of Dhaincha was 1900 kg/ha.

RECOMMENDATIONS

Further study on economic feasibility should be under taken to implement at the field level.

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