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Identifying the Suitable Extraction Method for Malu-A Bast Fibre

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Research Article

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ABSTRACT

Bast natural fibers have gained importance in recent years owing to their eco-friendliness and their potential availability as raw materials for textile industries. In the present study, the extraction and characterization of fibers from the stem of the malu plant was conducted for possible utilization in textile and home furnishing industries. The results indicated that alkali retted (0.5% NaOH for 10 hours) fibers had superior properties compared to the other methods. It had reasonably good fineness, tenacity, elongation percent, and required less time for extraction.

INTRODUCTION

Textiles prepared from natural fibers have attracted the scientific community's interest for an extended period. Return to natural fibers to meet our fiber needs is an important part of the change that is required if we want to achieve sustainable living. We must also return to traditional production methods which are chemical-free or uses minimul amount of chemicals that are dangerous to our environment. Unconventional or non-conventional fibers can be used as an alternative to synthetic fibers. These alternative fibers, including hemp, ramie, flax, sisal, kenaf, etc., are obtained with almost no pesticides during their production and less chemicals during their processing. These fibers are present in abundance all over India but still neglected everywhere. Apart from abundant availability these fibers possess characteristics like elegance in aesthetic appeal, comfort in wear, and many other utility performances as peruse in different applications, including clothing [1].

Bast fiber, also known as phloem fiber, is a type of plant fiber that is obtained from the phloem or bast surrounding the stem of certain dicotyledonous plants. Bast fibers can be obtained either from cultivated herbs or wild plants. The strands of bast fibers are usually released from the cellular and woody tissue of the stem by mechanical, biological, or chemical methods. Studies show that bast fibers have higher tensile strength than other natural fibers, thereby being usually used to produce high-quality textiles. Today there are many industries where bast fibers are processed and utilized, such as textiles, ropes, carpets, brushes, and mattresses industries, in addition to paper and board materials industries.

Malu (Bauhinia vahlii) is the gigantic climber and one of the most abundant Indian climbing *Bauhinia spp*. It is distributed in the Sub-Himalayan region ascending to 3,000' and is also found in Assam, Bihar, etc. Besides Asia these plants are widely distributed in warmer parts of the world including Africa, and South America being commonly known as "cow's paw", because of the characteristic shape of their leaves. They were named after two swiss botanists, the Bauhin brothers. Their seeds, leaves and stem barks have been used frequently in folk medicine as remedies for the treatment of diabetes, infections, pains, and inflammatory processes and have been confirmed through numerous biological studies. It can grow up to 10-30 m long and the woody stem can get as thick as 20 cm. The spreading stout branches are covered with fine rusty hair. In India, especially in Uttarakhand, this plant is abundantly found at higher hills, and fibers are extracted by the scraping method. These reddish-brown fibers are generally used to manufacture ropes by the local people. Local people use leaves of the plant to make pattal and wrap the "Singhori" a local but very famous sweet of uttarakhand. The present research is carried out to identify the suitable extraction method for malu fibers, which will enrich the textile industry and open new avenues for job opportunities for the local people as well as it will impart a positive impact on continuously degrading enviorment [2].

MATERIALS AND METHODS

Raw materials: For the present study, stems of malu plant (Bauhinia vahlii) were collected from Baluti village of Kathgodam, Haldwani, Uttarakhand (Plate No. 1). The researchers subjected these stems to different extraction methods to identify the best methods based on their impact on some physical properties of the fibers.

Extraction of Malu fibers-fibers from malu stems were extracted using various methods *viz*., water retting, fungal retting, chemical retting (acid and alkali retting), and scrapping methods to study the effect of these extraction methods on the quality and physical properties of the extracted fibers (Plate No. 2) [3].

Microbial retting: In this method, the bundles of malu stems were immersed in slow-running water. Extra weight was put over the bundles to keep them in place as natural gas formation may causes the bundles to rise on the water surface. The stem became soft and covered with green slime when sufficiently retted, which took 15 days. After the retting was over, the bundles were removed from the water and drained. Then fibers were removed by beating and scraping and thay were washed manually and dried under sunlight.

Fungal retting: Another method of retting was carried out according to another procedure. The malu stems were pounded with a wooden mallet and immersed in a big tub, and this tub was kept under shade to provide room for fungal growth, which causes the decomposition of plant material. After 15 days, when retting was completed, the decomposed material was taken out and the outer layer was scraped. It was then subjected to beating, washing, drying, and combing similar to microbial retting [4].

C.Chemical retting: Chemical retting was carried out by using various concentrations of NaOH and HCl (0.25% and 0.5%) 11. Malu stems were pounded with a wooden mallet. The bark of the stem was first scraped out and then pieces of malu stems were immersed in separate beakers containing different concentrations of NaOH and HCl solution in such a manner so that they were completely immersed in the solution. The beakers were covered with watch glasses and kept for 10 hours. After this, each of them was boiled for 30 minutes. The fibers were then washed with cold water to separate the fibers and then dried under the sun [5].

Chemical retting (long duration): Malu stems of equal length were pounded with wooden mallet and immersed in beakers containing 0.25% and 0.5% Hydrochloric acid (HCL) and Sodium Hydroxide (NaOH) concentrations. This was allowed to stand for several days until the stems were completely retted. At regular intervals, stems were turned upside down to ensure even retting. The retting process was completed in 10 days, and decomposed material was taken out from the beaker. With the help of a scraper, the fibers were extracted, and pulpy, non-fibrous material was removed. The extracted fibers were then washed in plenty of water several times to remove the traces of other material sticking to the fibers.

Scraping: Scraping is the traditional method followed by villagers to remove fibers from malu stems. In this method, the outer layer of the stem was first scraped out and then subjected to beating, washing, and drying. Initially colour of the fibers was cream which changed to brown after its extraction and processing. Scraping was the most economical among the above extraction methods as less time was consumed [6].

Evaluation of physical properties

Malu (bast) fibers extracted by water retting, fungal retting, chemical retting (acid and alkali retting) and scraping methods were evaluated for tensile strength, elongation, and fineness to find out the best extraction method. The fiber samples were conditioned to standard atmospheric conditions for 24 hours before final evaluation, which is 27 ± 2^{0}C and 65 ± 2% relative humidity as per IS: 6359-197112.

Fiber strength, elongation, and fineness: The strength, elongation, and fineness of fibers were determined using "Vibroskop 400" and "Vibrodyn 400" machines at Northern India Textile Research Association (NITRA), Ghaziabad. This is an advanced semi-automatic microprocessor with a controlled tensile strength tester [7].

The test method was based on the vibrating string principle. The linear density, or mass per unit length, can be calculated from the fundamental resonant frequency of a fiber's transverse vibration measured under known length and tension conditions. The following procedures are suitable for use on uncrimped fibers or on a fiber from which crimp is removed by the tension applied in the test. First, the fiber was tested on the Vibroskop 400 for fineness (denier) and result was noted from the screen of the monitor (ASTM D 1577-01). Then to work out the tensile strength and elongation, the same fiber sample was clamped with the help of forceps between the two jaws of Vibrodyn 400, adjusted at the gauge length of 20 mm. Then weight was removed without stretching the specimen. A tensile testing machine was started to extend the fiber specimen to break at the selected extension speed, and the data were recorded (ASTM D 3822-01). Twenty readings were taken for each sample, and an average value was calculated [8].

RESULTS AND DISCUSSION

Effect of different extraction methods on physical properties of malu fibers: Malu fibers were extracted by various methods (water, fungal, chemical retting and scraping) to study the effect of these extraction methods on the

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properties of extracted malu fibers (Figure 1,2 and Table 1) [9].

Figure1. Malu plant *(Bauhinia vahlii)*.

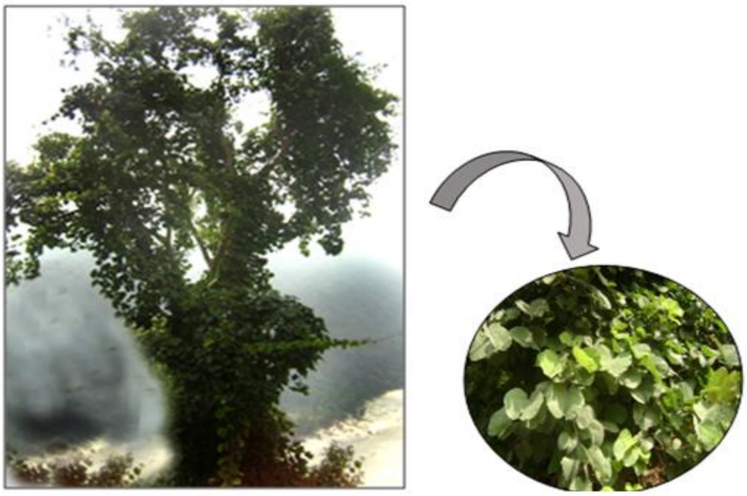

Figure 2. Extraction of malu (bast) fibre by scrapping (a), Water retting (b), Fungal retting (c)

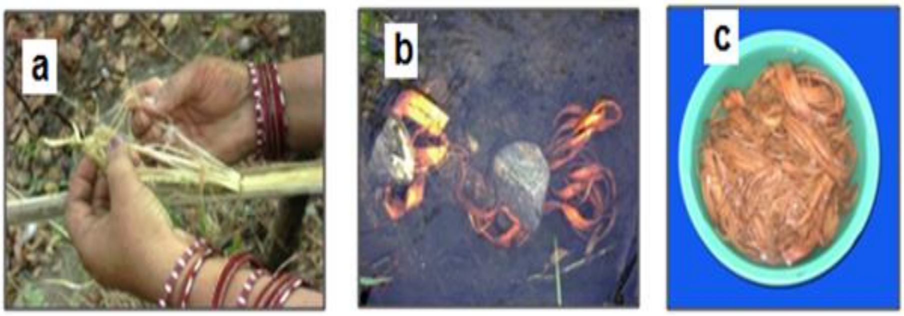

Table 1. Effect of different extraction methods on fineness, tenacity and elongation of malu fibers.

S.No.	Extraction methods	Fineness (den)	Tenacity (g/den)	Elongation (%)
1	Scraping	147.43	1.46	6.01
2	Water retting	69.5	0.96	4.74
3	Fungal retting	71.36	1.45	4.91
	Acid retting			
	0.25% HCl (10 hrs.)	76.03	1.6	5.02
	0.50% HCl (10 hrs.)	71.82	1.43	4.99
	0.25% HCl (10 days)	67.94	1.22	4.98
4	0.50% HCl (10 days)	64.74	1.1	4.92
	Alkaline retting			
5	0.25% NaOH (10 hrs.)	66.82	1.79	5.52

	0.50% NaOH (10 hrs.)*	61.28*	1.77*	5.46*
	0.25% NaOH (10 days)	59.79	1.76	5.28
	0.50% NaOH (10 days)	59.17	1.71	5.26

It is evident from Table 1 that alkali retting with 0.50% NaOH for 10 days produced fibers with minimum fineness values i.e., 59.17 denier. The fineness value of the malu fibers was maximum in the case of the scraping method (147.43 den) followed by acid (76.03 and 71.82 den with 0.25% and 0.5% HCl respectively for 10 hrs), fungal (71.36 den), and water retting (69.50 den) methods. During chemical retting, it was observed that fibers became finer as the concentration and duration of chemical treatment was increased. It is evident from the above results that the finest fibers can be extracted with the alkali retting method than the fibers extracted by other retting methods. This may be because non-cellulosic incrustation like hemicelluloses on alkali treatment was removed and hence the fiber became finer [10].

Similar results were also observed in one of the study and they reported that with the alkali treatment, the linear density of jute fibers decreased in general, suggesting that the fibers had become finer. Jute fibers became increasingly finer with the increase in the concentration of NaOH solution. It seems that alkali treatment might have brought about splitting pseudo-single fibers due to the removal of hemicelluloses. Few studies also reported that the chemical retting of kenaf fibers with NaOH rapidly removes nonfibrous materials. The amounts of lignin, pectin and hemicelluloses varied with the type of retting treatment. After chemical retting, hemicelluloses and pectin content were observed to decrease with increased NaOH concentration [11].

In terms of tenacity, the maximum tenacity was reported in the case of alkali retting (1.79 to 1.71 g/den) followed by acid (1.60 g/den with 0.25% HCl concentration for 10 hours), scraping (1.46 g/den), and fungal (1.45 g/den) retting methods. The reason behind increase in tenacity with alkali retting is that the mineral acids degraded cellulosic fibers, whereas strong alkalis such as sodium hydroxide swell the fibers, and fiber became stronger, as in the case of mercerization treatment. But as the concentration and duration of the chemical (HCl and NaOH) retting increased, the tenacity of the fibers deteriorated. Sen et al. also reported that both the tenacity and fineness values of bhindi (*Hibiscus esculentus L*) fibers decrease on treatment with alkali of higher concentration. Minimum tenacity was found in water retted malu fibers i.e. 0.96 g/den followed by acid retted fibers (1.10 g/den with 0.5% HCl for 10 days) [12].

It is also evident from Table 1 that the elongation percentage was found maximum in case of fibers extracted by scraping method (6.01%) followed by alkali (5.52 to, 5.26%) acid (5.02 to 4.92%) and fungal retted (4.91%) malu fibers. The minimum elongation percent was observed in the case of malu fibers extracted by the water retting (4.74%) metho [13].

The above results indicate that alkali retted fibers had superior properties compared to the malu fibers extracted by other methods. Therefore, from different alkali retting methods, 0.5% NaOH for 10 hours was selected as the best method for extraction of fibers from malu stem. It had reasonably good fineness and tenacity, elongation percent and required less time for extraction. Madan also carried outfibers extraction from Girardinia plants by four methods *viz*. water retting, fungal retting, acid retting and alkali retting. She observed that fibers obtained from water retting and acid retting were greenish in colour and were coarser to touch whereas the fibers obtained from fungal retting had become so soft that they hardly retained any strength. The fibers obtained from alkali retting yielded good quality fiber. Therefore, the alkali retting method was chosen as the best method for extracting Girardinia fibers [14].

CONCLUSION

The Himalayan region in India provides an area rich in natural resources that lagged in industrial development. These fiber-containing plants such as malu are considered as waste and are not exposed for their application in varied textile products due to the lack of knowledge about their utilization. Proper production, extraction, and processing of this fibre can be beneficial for the economic development of that area as well as open up new dimentions in other conventional and industrial textile uses.

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