Improvement of Jute Retting Processes in India in the Context of Water Scarce Situation

Deb Prasad Ray, Pradipta Banerjee and Debashis Nag

National Institute of Research on Jute & Allied Fibre Technology. 12, Regent Park, Kolkata-700040, India.

ABSTRACT

The jute industry is facing severe competition from synthetic packaging materials in the present situation. To sustain the jute industry and to uplift our benevolent mother nature there is a natural intention to move towards more diversified products like fine jute yarn, high quality home furnishing jute fabrics, light shopping /carrying bags, various innovative gift articles & decorative products, requiring higher quality fibre. Thus with the growing demand of high quality fibre the economic significance of fibre quality is also increasing on which the future of jute will ultimately depend to a great extent. Despite the fact the amount of quality fibre is not increasing at the desired level. This is mainly because the farmers after putting all their efforts in cultivating the crop are least bothered or negligent about the post harvest techniques and are using the same age old retting practices without caring about its impact on the fibre quality mainly due to lack of proper knowledge and awareness about its benefit or adequate incentive / financial benefit.

Keywords: Jute retting, Retting improvement, Water scarcity, Fibre quality

Retting Concept

The concept of 'retting' originates from rotting of anything and is very much pertaining to jute extraction where it meant partial rotting of jute plant. It is a biological process in which the bast fibres are extracted by decomposing the plants through the joint action of water and aquatic microorganisms, mostly bacteria. It is the most important and predominant of all the factors influencing the quality of jute/kenaf/mesta fibre. Retting along with other factors influences the main characteristics or parameters, which determine the quality of fibre like strength, colour, lustre and texture including cuttings i.e. the hard bottom parts of the fibre. Since long, scientists in the R&D organizations in Jute growing countries have been conducting different researches to evolve location specific, sustainable and cost effective retting techniques and develop machines like ribboner /fibre extractor/ decorticator etc. Accordingly some significant successes have been achieved. Among the developed jute retting techniques, covering jute ret with water hyacinth, ribboning and ribbon- retting technique (for water scarce areas) etc. are mostly recommended in the jute growing countries.

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Address for correspondence

National Institute of Research on Jute & Allied Fibre Technology. 12, Regent Park, Kolkata-700040, India.

E-mail: drdebprasadrat@gmail.com

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National Institute of Research on Jute and Allied Fibre Technology, Kolkata has evolved a cost effective retting technique by which the quality of jute fibre has been possible to be up-graded at least by one grade. This technique has been found easier and cost effective for jute retting by the jute growers in India. With a view to popularizing this retting technique both in India and Bangladesh

The retting process

The most common and well adopted method of retting is stem retting in which the complete plants are immersed in a water body in bundles of multiple layers known as 'rets'. The retting is actually accomplished through decomposition process in water. The natural microorganisms present in water contribute a lot for this decomposition. The organisms act on jute tissue and gradually soften and loosen them. As the fibre portion is resistant to microbial decomposition it remains intact when washed away.

For obtaining a good quality fibre, time of retting is very important. In case of under retting or over retting the fibre quality degrades in both ways. Under retting causes production of barky fibre. Over retting exerts the excess microbial attack on plant parts including fibre portion causing production of weaker quality fibre.

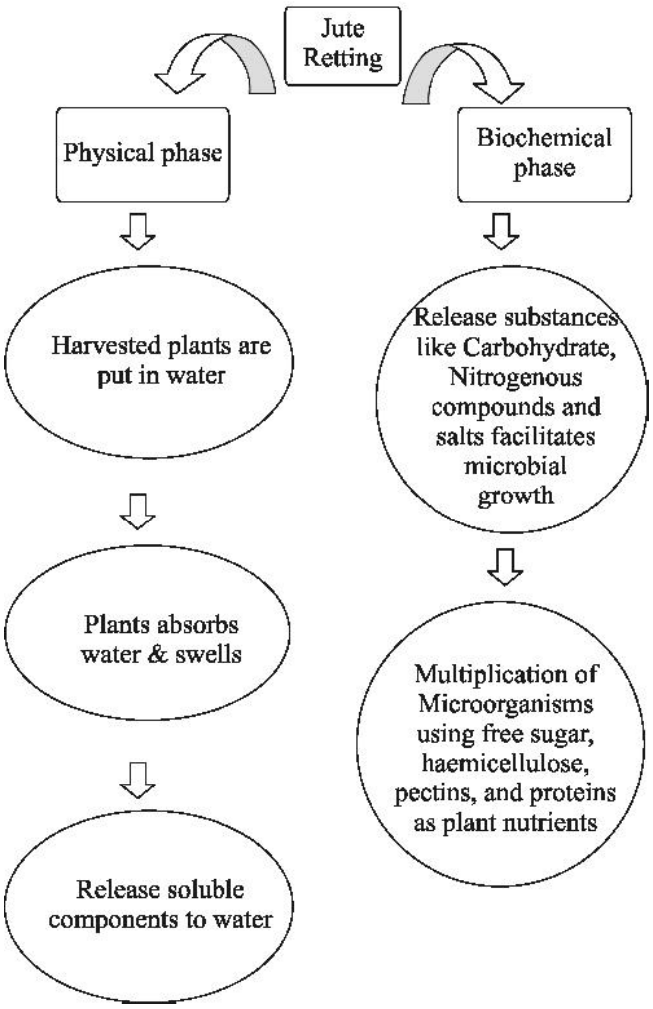
Traditional retting

Most of the jute growing countries have evolved their own traditional method of jute retting. Basically the retting of jute done by traditional method has been learnt through experience. Collecting whole plants in bundles after shedding leaves and then submerging these bundles in the retting area are the common practice in traditional retting. While preparing the "Jak", the bundles of jute plants are arranged in such a way that there remains ample space for easy flow/ movement of water and retting microbes. Jaks are made in different layers of jute bundles. In one layer, the bundles are arranged side by side lengthwise, then in the second layer they are arranged perpendicular to the first layer and in the third layer they are again placed as the first layer and so on. To accelerate the retting of jute urea @ 0.01% is used as per the recommendation of retting practice. The jute plant bundles are submerged by using banana stems/ water hyacinth etc. as weighting material. Through physical testing periodically when the jute plants are found to have been properly retted the fibres are manually extracted from the retted plant. Better fibres are obtained if extraction of fibres are done on the ground taking single or two plants at a time. After extraction, the fibres are washed thoroughly in clean water so that the fibres are freed /cleaned from broken jute sticks, cuticular layer of barks, clay or any other dirt. After washing, the fibre is well dried by hanging in bamboo frame or by placing on clean ground.

Low Cost retting

This is only a slight modification of the traditional retting process. The common farm practice remains collecting whole plants in bundles of about 10kg then leaving these bundles in the fields for 3-4 days for shedding leaves and then submerging these bundles in the retting area. After bundles of jute crop called 'Jak' (preparation of 'Jak' has been described under section B. Traditional retting) are placed for retting in the water, a piece of old /discarded jute cloth of heavy construction (or gunny) is spread over the top to cover the jak /the plant bundles. The end portion /the edges of the gunny need to touch the water surface so that capillary action of water may prevent the crop from drying up and ensure smooth retting. Non-contaminating loads are made by packing bricks/stone chips in bags and sewing them. These reusable bags are used to submerge the jute crop again and again. During the retting period, whenever the farmers had a chance to go to the site, they splashed a bucket of water or two from the same place over the fabric covering the crop. This allowed intake of fresh water on the top portion and carried down the waste material absorbed in the top portion and kept the 'jak' wet /submerged and protected the surface of plant bundles getting dried from direct sunrays. Tests for end of proper retting, extraction of fibres, washing and drying processes remained the same in all cases.

Phases of Jute retting:



Improved Retting And Extraction Techniques

Retting is very common in local ditches, way side water bodies, canals and pond that are meant for community use owing to shortage of water. Due to intensive cultivation and erratic rainfall pattern water scarcity is prevalent phenomenon in the Jute growing areas. This jute out of traditional retting are of low in quality as there is no control over the water quality and temperature. Apart from this, the retting of jute results in polluting and stagnant water thereby causes the environmental pollution. The stagnant polluted water subsequently becomes breeding ground of mosquitoes. Traditional retting involves utilization of manpower inside these polluted water bodies causes various skin diseases and other health problems. Therefore, there is a certain trend of shifting of profession of the labourers from jute processing to other job which created a huge man power shortage in obtaining the quality jute products which contribute to production of jute diversified product.

Chemical retting: It is an easy, efficient method of retting bast fibres to produce clean, consistent long, smooth fibre within 60-75 minutes using sodium thiosulphate, sodium hydroxide, hydrogen peroxide, sodium benzoate, ammonium oxalate, urea and similar salts. But the major disadvantage is that the fibre may lose tensile strength on treatment with hot alkali. Moreover, the unfavorable colour and high cost makes it unsuitable for retting in large scale (Kawahara *et al.*, 2005; Mooney *et al.*, 2001).

Biological retting:

Bacterial cultures: NIRJAFT has screened a large numbers of water bodies used for retting, identified a mixed bacterial culture capable of retting in 2-3 days and kept samples of the culture for experimentation. Similar work was undertaken in Bangladesh, Thailand and Indonesia. The IBFC China succeeded in retting kenaf in three days using a special microbial culture multiplied in an incubator and then released into ground water.

Fungal cultures: The NIRJAFT screened fungi of different origins and found that they are capable of retting jute ribbons satisfactorily, under laboratory conditions. Post-retting treatments with the use of fungal cultures were also examined to minimize the effect of cuttings on the fibres by removing the hard and barky bottom portion without adversely affecting other fibre qualities. *Aspergillus* sp. was found to be beneficial in improving the quality of fibres produced by one or two grades.

Microbial Culture Bank: Potent strains of microorganisms have been identified and one bank of isolated cultures has been maintained for bio-processing of jute and allied fibre. This culture bank has a collection of 54 bacterial and 50 fungal cultures. These cultures are regularly utilized by the scientists. These cultures have potential application for bioprocess like retting of green jute plants, softening of hard barky jute, degumming of ramie fibre, pulping of jute stick, etc. The cultures are being maintained bu sub-culturing them periodically in their respective media. Continuous up gradation of the stock is done by isolating new cultures from

various natural sources and checking their efficiency for such bio-processes. Banik and Ghosh (2008) reported that pectinolytic microorganisms grow in jute piles and consume residual pectin on jute fibres to improve their pliability. Thus, development of potent pectinolytic microbial culture and its application in jute piles improves yarn quality.

ALTERNATIVE TECHNOLOGY: THE 'RIBBON RETTING'

Restricted availability of water, distance from the jute field to retting pond, shortage of labourers, low wages pattern etc are delineated to rethink of jute retting processes. Moreover, the quality of the fibre produced varies from place and to place pond. Therefore for production and sustenance of quality jute production alternative technologies were deployed. 'Ribbon retting' is one of the technology which has a futuristic approach for higher grade jute production with low water requirement. The National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT), Kolkata under the aegis of Indian Council of Agricultural Research has developed a technology for quality jute production avoiding excessive dependence of water and minimizing duration of water.

What is 'Ribbon Retting'?

For proper retting in both the techniques, traditional and the low cost retting, require sufficient water. In the present situation, when jute cultivation is continually shifting to marginal lands scarcity of water is posing serious concern to the farmers for jute retting. Inadequate retting facilities particularly non-availability of sufficient quantity of water for retting is affecting the quality of fibre to a great extent. (Ray *et al.*, 2013).

In order to solve this problem with efficient use of water a number of ribboner /fibre extractor /decorticator including ribboning techniques have been developed by different R&D organisations/ institutions of India and Bangladesh. Of which two retting techniques especially developed for the water scarce areas, one by NIRJAFT and the other by BJRI have also been well documented to the farmers and attracted huge attention in its effectiveness in water scarce areas as compared to the low cost and the traditional retting techniques.

This technique has been found to be simple, effective and acceptable to the farmers in India in consideration that it improves the fibre quality by at least one grade within a shorter retting period/time without deteriorating the quality of water and almost without any additional cost involvement. It is estimated that conventional retting requires a lot of water as much as 2,500 litres for a quintal of jute or mesta. It can be reduced to about 120 litres in ribbon retting.

A ribboner machine is used to take out the jute/mesta bark and then a microbial growth promoter, christened 'Sonali Sathi,' is mixed with water in powder form. Not only does it improve the fibre quality, but the time for retting is also considerably reduced. The farmer can save on water and labour as well.

NIRJAFT Process for accelerated retting

Jute is generally harvested between 100-110 days of sowing. Green ribbon or bark is extracted from jute plants after harvesting by the Jute Ribboner machine developed by NIRJAFT. Over matured stalks pose a problem of ribboning and are difficult for complete retting resulting in poor yield and inferior quality. Green ribbons are made into small bundles and weighed as 2.5 times of water on ribbon weight is required for retting. The bundles of ribbons are tied at the top, middle and bottom positions lengthwise for easy handling. Some chemical accelerator /white powder (non-toxic and non-hazardous) evolved and distributed by NIRJAFT only is dissolved in water in required quantity. The concentration of solution is 5-7 g/ litre of water (Ray *et al.*, 2014). The bundles of ribbons are placed into a make-shift polythene retting tank or a cemented tank and the retting solution is poured in it. The ribbon : water ratio is maintained at 1:3 during the retting period of about 10 days. The tank i.e. the soaked ribbons are covered with a polythene sheet to check evaporation and maintain the liquor ratio and also to protect from dirt. The soaked ribbons are taken out after 10 days and washed in clean water and dried in the sun to obtain good graded fibre.

Ribbon retting technique of Bangladesh Jute Research Institute (BJRI), Bangladesh

With an objective to minimize the retting water problem, prior to retting, the green bark of the jute plants are

separated by ribboner (single/double roller) evolved by BJRI. Then the bark of the plants from the maletted area is separated in two halves and the woody core is placed in the middle of the hook. The halves of the barks are taken around the two notches of the hook and drawn inward with a sudden forceful pull. This throws the woody core (jute stick) to a long distance ahead, leaving the barks or ribbons of the plants in the hands of worker (operator). Green ribbons /barks of three to four plants can be extracted in this way at a time. Before retting these ribbons are arranged in the form of a ring and are retted in polythene lined artificial retting tanks/ditches/shallow water pool etc. Urea @ 0.01% or retting effluent can be used as retting accelerator.

Factors affecting Retting and Extraction of Jute Fibre:

After completion of retting, the bundles are taken out of water and fibre is extracted manually one by one i.e., single plant extraction or by beat-break-jerk method i.e., multiple plant extraction. It is reported that the factors affecting quality of retting are nature and volume of water, temperature, Ph, age of harvested crop, fertilizer used for the crop, activator used for retting, disease which affects retting time, etc. (Roul, 2009). The factors upon which retting efficiency depends, are discussed below:

(i) **Age of the plant:** Extraction of fibre from jute plants depends on the age of the jute plants. The mature plants above 110 days accumulate more of lignin and therefore, difficult for decomposition and hence reduces extraction efficiency.

(ii) **Water quality:** Non-polluted and moving water is congenial for retting and extraction of jute. Water pollution causes low graded fibre yield. Moving water helps to enrich the oxygen into the water and hence maintains the biological oxygen demand of the retting flora and hence extraction efficiency increases. Retting is best carried out in slow moving clear water (Kundu *et al.,* 1952) with low contents of salt, iron and calcium.

(iii) **pH of water:** It has been observed that water pH between 6.0-8.0 is convenient for jute retting (Ali and Alam, 1973). This may be due to congenial pH range of microorganisms' growth.

(iv) **Temperature:** The optimum temperature for jute retting is 34 – 36°C and in this ranges the retting is fastens due to accelerated activity of retting microorganisms.

(v) **Depth of Water:** Microbial action in retting water is maximum at a depth of 15 cm from the surface of water and retting is quicker and better at this depth. Some microbial action is evidenced even up to depth of 35 cm, but below this no effect has been observed.

(vi) **Role of natural activators:** Natural activators like dhaincha (*Sesbania aculeata*) and sun hemp (*Crotolaria juncea*) which are generally introduced into the jute stem bundles before they are put in water for retting (Ahmed and Akhter, 2001). The leguminous plants being rich in nitrogenous content help the growth and activity of retting microbes by supplying additional nutrients to them.

GRADES AND GRADING SYSTEMS

India

In India the quality of jute fibre is usually judged by its suitability for the production of different types of yarns and its behavior in the manufacturing processes. The BIS grading of jute envisage a score card system of grading that aims at eliminating personal bias as far as practicable. Six physical parameters viz., strength, fineness, colour, root content, defects and density of jute fibres are assessed for sorting out the fibre into eight different grades. Relative weight age is given to each physical parameter by standard scoring system and the grade of fibre is determined by total score of the six parameters.

Based on the grading, each one is further classified on a scale of 1 to 8 (where 1 is the best grade and 8 is the worst). The best quality fibre of Tossa varieties viz., TD-1 has been awarded total score100 (Saha *et al*., 2013). The classification is done for Tossa as TD1 , TD2 . . . TD8 or for White as WD1 . . . WD8. (Table …… and ……)The highest production is that of Tossa fibre which accounts for nearly 78%, followed by White which is 10%.

Factors in Jute Grades

- ❒ Quality varies from place to place and season to season
- ❒ Topography, nature of soil and water, rainfall, humidity, practices followed in growing, methods used in retting extraction of fibre, washing, drying, storage

Basis of Grading

- ❒ Length, strength, colour, lustre and weight
- ❒ General qualities like softness, smoothness, distinctness and uniformity of the fibre
- ❒ Proportion of cuttings, hard-centred fibre and harsh crop ends, and
- ❒ Proportion of faults such as roots, bark, sticks, specks, knots, runners and watermarks

Grading Process:

There are two systems for grading of jute

(a) **Hand and Eye Method:** An expert grader can assess the physical characteristics viz., fineness, density and strength of the fibre by his experience testing by hand only while visual assessment will judge colour, root content and defects by a close look at the fibre. Hand and Eye method is generally used in the market for on spot assessment of the quality and grading of fibres. This method is subjective and assessment may vary from grader to grader.

(b) **Instrumental Method:** In this method all the six physical characters of fibre essential for determining grade are measured by fibre testing instruments. The use of instruments is essential for as accurate and objective evaluation of grades.

Table 1. BIS Standard for each grades of Tossa Jute (IS 271-2003)

Grade	Strength	Maximum Defects	Max. Root Content (by weight)	Colour	Fineness	Density	Total score
TD1	Very good						
(30)	Free from major & minor defects (25)	5 per cent (20)	Very good (10)	Very fine (10)	Heavy bodied (5)	100	
TD2	Good						
(23)	Free from major & minor defects (25)	8 per cent (18)	Good (7)	Fine (7)	Heavy bodied (5)	85	
TD3	Fairly good						
(20)	90% of the fibre should be free from major & minor defects and only 10% of the fibre should be allowed to contain loose leaf and specks (22)	10 per cent (15)	Fairly good (5)	Fibres well separated (5)	Medium bodied (3)	70	
TD4	Fair average						
(18)	Free from major defects and not more than 20% fibre should contain specks & loose sticks loose leaf and specks (22)	15 per cent (10)	Fair average (4)	Fibres separated (2)	Medium bodied (3)	55	
TD5	Average						
(16)	Free from major defects (14)	20 per cent (5)	Average (3)	Fibres separated (2)	-	40	

TD6	Average						
(16)	Free from centre root and dazed/ over-retted fibres (5)	25 per cent (4)	-	-		25	
TD7	Weak mixed (5)	Not more than 50% fibre should suffer from major defects (2)	35 per cent (3)	-	-		10
TD8	Entangled or any other jute not suitable for any of the above grades but of commercial value	0					

Table 2. BIS Standard for each grades of White Jute (IS 271-2003)

Grade	Strength	Maximum Defects	Max. Root Content (by weight)	Colour	Fineness	Density	Total score
W1	Very good						
(25)	Free from major & minor defects (25)	5 per cent (20)	Very good (10)	Very fine (15)	Heavy bodied (5)	100	
W2	Good						
(20)	Free from major & minor defects (25)	8 per cent (18)	Good (7)	Fine (7)	Heavy bodied (5)	85	
W3	Fairly good						
(18)	90% of the fibre should be free from major and minor defects and only 10% of the fibre should be allowed to contain loose leaf and specks (22)	15 per cent (15)	Fairly good (5)	Fibres well separated (5)	Medium bodied (3)	70	
W4	Fair average						
(15)	Free from major defects and not more than 20% fibre should contain specks and loose sticks loose leaf and specks (18)	20 per cent (10)	Fair average (4)	Fibres separated (5)	Medium bodied (3)	55	
W5	Average						
(13)	Free from major defects (14)	25 per cent (5)	Average (3)	Fibres separated (5)	-	40	
W6	Average						

(13)	Free from centre root and dazed/ over-retted fibres (8)	30 per cent (4)	-	-		25	
W7	Weak mixed (5)	Not more than 50% fibre should suffer from major defects (2)	40 per cent (3)	-	-		10
W8	Entangled or any other jute not suitable for any of the above grades but of commercial value	0					

Some key notes for Grading of Jute:

1. The minimum reed length should be 150 cm, or the effective reed length should not be less than 100 cm except for TD8/W8.
2. Jute should be in dry storable condition
3. Jute should be free from HUNJA, mud and other foreign materials.
4. Natural dust may be allowed in grades TD3/W3 to TD8/W8 with proportionate discount.
5. Root content will include hard barky croppy ends.
6. A parcel of jute which would not secure full marks for a particular grade shall still be considered for the grade with suitable discount to be settled between buyer and seller, provided its score is not less, by 50 (or more) percent of the difference, between the maximum scores for that and the next lower grade. When the score is less by 50 (or more) per cent of the difference, the buyer will have option to reject or settle with suitable discount. Scores on the table may be taken as guidance for determining the discount.
7. For instrumental determination of various characteristics like strength, defects, root content, fineness, bulk density etc. reference to the relevant part of IS 7032.

CACP grading for Price Fixation

Commission for Agricultural Costs and Prices (CACP) has introduced a new grading system of 5 grades with five parameters from 2015-16. CACP has formulated the system taking into consideration of NIRJAFT's User-friendly grading system, which was developed very recently consultation with different stake holders. 5 parameters are strength, root content, defects percentage, fineness and colour. Maximum score marks for different parameters have been taken from NIRJAFT's User-friendly Jute grading System. Minimum Support Price of jute fibre has been declared after that grading system for the year 2015-16 (Table 3).

Table 3. CACP Grading Score for Jute Fibre

Grade	Strength	Defects	Root content	Fineness	Colour	Total Score
TDN1	Need less strength to break the fibre and sound will be available at the time of breakage (Good 23)	90% free from major defects but 20% minor defects may be allowed (17)	> 05% - 8% length wise			
(15)	Very Fine					
(15)	Light creamy to reddish yellow with lustre (10)					
80						
TDN2	Need less strength to break the fibre and sound will be available at the time of breakage (Good 23)	80% free from major defects and 30% minor defects may be allowed (09)	> 08% - 10% length wise (08)	Fine		
(10)	Light creamy to reddish yellow with lustre (10)					
60						
TDN3	Need less strength to break the fibre and feeble sound at the time of breakage					
	80% free from major defects and 30% minor defects may be allowed (09)	> 08% - 10% length wise (08)	Coarse			
(05)	Reddish / brownish with some light grey (05)					
40						
TDN4	Easily break the fibre and no sound at the time of breakage (Poor 04)	70% free from major defects (05)	> 10% length wise (03)	Coarse		
(05)	Light grey to dark grey (03)					
20						
TDN5	Entangled or any other jute not suitable for any of the above grades but of commercial value					

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