Reducing the Time of Coir Retting by Changing the Conditions of Microbial Environment

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Introduction

The coir industry in Sri Lanka had a great history as a main coconut based industry which contributing to the economy of Sri Lanka. There are two types of coir are produced in Sri Lanka as Brown fiber and White fiber. Sri Lanka is the largest supplier of brown fiber to the world. Sri Lanka produces about 36% of the world brown fiber production and exports of coir and coir products amounted to rupees 11.6 billion in 2008 (CDA, Coconut Statistics - 2008). But today Sri Lanka has faced to difficulties because of the low productivity compared with other competitor countries. Due to longer retting period and augmenting the microbial activities is one way of shortening retting time. According to Fernando et al., (2010) *Bacillus firmus, Bacillus macerans* and *Bacillus badius* bacteria can use to obtain good quality bristle fiber within 21 days. The coconut husk which is a fibrous material that covers the fruit of *Cocos nucifera* is the raw material for extracting coir fiber. The retting process is responsible for the separation of bristle fiber from the husk and it undergoes two distinguished physical and biological changes. The biological process can be accelerated by enriching the retting media with microbial nutrients. Therefore, this study was done to reduce the retting time of coir by changing the microbial environment of retting tank and to increase the productivity of Sri Lankan bristle fiber.

Methodology

Retting of coir and the microbial studies were done at the microbiology laboratory of Uva Wellassa University in Sri Lanka. Coir extraction and quality analysis were done at Coir Research and Development Institute in Nattandiya.

Coconut husks with same maturity and same length were used and then crushed and cut in to pieces with similar width. The retting was done in three stages; the preparation of nutrient media, changing the pH of retting environment and aeration the retting tank. To enrich retting media there were two nutrient mixtures as 50% of Coconut water + 6 g Sago + Fresh water and 75% of Coconut water + 6 g Sago + Fresh water mixture. The total volume of the retting tank was 14 L. There were two nutrient levels as 50% of nutrient media from total volume of retting tank and 75% of nutrient media from total volume of the retting tank.

There were six treatment combinations and the control. Treatments were arranged according to 3x2 factorial design. Six increasing retting days were used as 7, 14, 21, 28, 35 and 42 days. At each week microbial studies and coir quality analyses were done. Total plate count of microorganisms was taken at weekly intervals to determine the change of microbial population density during retting.

The pH value of the retting media was adjusted by adding 1N Sodium hydroxide (NaOH) to the media at first day of retting. The aeration was done by using air pump in 3 L/min output and 0.012 Mpa pressure (Model U-8800, BOYU International village, North city, Raoping, Guangdong, China). The aeration level was same for each and every retting tank.

After completing above three main stages the prepared 20 husk pieces of coconut husks were added into each treatment and also to the control. Three husk pieces were taken out from each treatment in weekly intervals and defiberd using defibering machine.

For microbial analysis Spread plate technique was used. Colony Forming Units (CFU) on the plates were counted using a colony counter. Bacteria were identified based on colony characteristics and Gram staining methods. The breaking load and Elongation at break of fiber were measured by using a Tensile Strength Tester. Evaluation of physical requirements of coir was done by analyzing weighted average tensile strength, fineness, size distribution of coir, average length distribution and average diameter distribution of coir in each sample. pH of treatments were measured daily.

All treatments were triplicated and the results reported are means of the three replicates. The data were subjected to ANOVA using two factor factorial designs with statistical analysis system ANOVA procedure. Grouping Mean score values in Tukey method were taken to analyze retting time, Quality of coir and Colony Forming Units (CFU). Sample means were compared for significance of difference is 0.05. All the analyses were done by using MINITAB 16.

Results and Discussion

The breaking load for defibering 1-tie coir is 3.4 - 4.7 N. If the breaking load is higher in a coir sample it indicates that the retting of coir has done preferably. Therefore, treatment 5 and 6 were reduced the time of coir retting up to 14 days and best mean value resulted for breaking load was given by the treatment 5 in 28 days of retting. The estimated elongation at break for defibering 1-tie coir is 23.5%. According to the results all the coir samples present in all treatments were in the required level. Treatment 5 and 6 were significantly differing for elongation at break from other treatments in 14 days and 21 days of retting. If the elongation at break is higher in a coir sample it indicates that the retting of coir has done preferably. The elongation at break of a coir sample increases when water molecules are absorbed by coir to inner cells (Table 1).

Table 1. Mean grouping of Breaking Load and Elongation at Break of coir with retting time (days)

Treatments	N	7 days		14 days		21 days		28 days		35 days		42 days	
		BL	E	BL	E	BL	E	BL	E	BL	E	BL	E
T1	15	2.2^{B}	21.0^{A}	3.6^{C}	28.4^{C}	3.8^{B}	33.1^{C}	4.0^{CD}	35.0^{C}	4.60^{AB}	40.0^{C}	4.43^{AB}	40.3^{B}
T2	15	2.9^{B}	21.1^{A}	3.7^{BC}	28.4^{C}	4.1^{B}	31.4^{D}	4.3^{BC}	34.1^{D}	4.19^{AB}	39.0^{D}	4.19^{BC}	43.4^{B}
T3	15	3.3^{A}	22.3^{A}	4.3^{AB}	31.8^{B}	5.0^{A}	39.6^{A}	5.0^{ABC}	41.6^{ABC}	4.72^{A}	43.7^{C}	4.54^{AB}	45.8^{B}
T4	15	3.2^{A}	22.9^{A}	4.4^{AB}	33.6^{A}	4.0^{A}	36.2^{B}	5.3^{AB}	39.9^{BCD}	4.64^{AB}	42.0^{C}	4.43^{AB}	44.0^{B}
T5	15	3.2^{A}	21.9^{A}	4.5^{A}	37.5^{A}	5.0^{A}	42.6^{A}	5.8^{A}	48.2^{A}	5.07^{A}	51.4^{A}	5.07^{A}	52.9^{A}
T6	15	3.2^{A}	21.4^{A}	4.8^{A}	37.7^{A}	5.0^{A}	41.6^{A}	5.5^{AB}	43.7^{AB}	4.73^{A}	44.4^{B}	4.70^{AB}	46.0^{B}
T7	15	2.9^{C}	20.8^{A}	4.2^{ABC}	31.4^{B}	3.4^{B}	34.6^{C}	3.5^{D}	44.5^{AB}	3.64^{B}	49.0^{A}	3.64^{C}	52.3^{A}
P-value		0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.001	0.000

N = Sample size BL = Breaking Load (N) E = Elongation at break (%)

T7 = Control

*****Means followed by same letter in each column are not significantly different at P=0.05.

In the study which conducted to estimate the microbial loads revealed that; within 14 days of retting, treatment 3, 4, 5 and 6 had the highest average number of microorganisms (table 2). Optimum pH range, nutrients and aeration would be the reason for the increasing the number of microbial level. The samples were contained Gram positive, single or short chained, uniform stained, thin walled, aerobic, rod shaped bacteria. Agar colonies were small, round, smooth and opaque or whitish. And also it had fecal odor. These characteristics are complied with the morphological, biochemical and physiological characteristics of the *Bacillus* spp. (Bergey's Manual, 1957). Therefore, the treatments were increased the growth of bacteria which are beneficial for retting of coir.

Table 2. Colony forming units (CFU) with retting time (days).

Treatment	N	Colony Forming Units (CFU)						
		1st day	7 days	14 days	21 days	28 days	35 days	42 days
T1	3	4.124 A	5.9542 B	6.07554 C	6.0656 B	6.0266 B C	6.0218 C	6.0100 C
T2	3	4.124 A	5.9411 B	6.0594 B	6.0543 B	6.0071 C	6.0043 C	5.9912 C
T3	3	4.368 A	6.0838 A	6.4194 A	6.4199 A	6.3879 A	6.1303 A	6.1227 A
T4	3	4.368 A	6.0778 A	6.4237 A	6.4171 A	6.3808 A	6.1161 A	6.1117 A
T5	3	4.301 A	6.0731 A	6.4127 A	6.4232 A	6.3667 A	6.106 A B	6.0957 AB
T6	3	4.368 A	6.0743 A	6.4059 A	6.4008 A	6.3636 A	6.0632 B	6.0556 B
T7 (Control)	3	4.221 A	5.7782 C	6.0156 B	6.0669 B	6.0803 B	6.0669 B	6.0619 B
P- value		0.102	0.000	0.000	0.000	0.000	0.000	0.000
R-Sq(adj)		26.83%	95.80%	98.83%	99.46%	99.30%	88.36%	87.95%

N = Sample size

*****Means followed by same letter in each column are not significantly different at P=0.05.

Treatment 5 and 6 were in required level for tensile strength of bristle coir in 14 days and they were significantly different from other treatments. Weighted average tensile strength was increased from 7 days to 42 days. According to the statistical analysis of Morsyleide et al, 2009 it showed that the treatment with NaOH had the highest effect on tensile strength (TS) and tensile modulus (E), producing composites with the best tensile properties. All treatments showed estimated values for fineness of coir from 14 days of retting. Within 7 days of retting treatment 4 was significantly differing from other treatments and were in required level for average length of defibering 1-tie coir. Within 28 days, treatment 3, 4, 5 and 6 were obtained highest mean values for average length of defibering 1-tie coir. Optimum NaOH concentration, optimum levels of nutrient supplement for maintain suitable growth environment of retting bacteria may be the reason for this situation. When the average diameter of the coir increases the tensile strength of coir would be decreased. Therefore, treatment 3, 5 and 6 were given best results within 7 days of retting. From 1 to 4 th week the pH of retting media was in the range which suitable for the growth of bacteria. After 4 th week the pH of retting media had decreased. Acid formation during souring of coconut water and hydrolysis of starch can be the reason for this situation.

Conclusions

Treatment combinations 50% of nutrient media, 3 L/min air volume with pH 9 and 75% of nutrient media, 3 L/min air volume with pH 9 give relatively higher best results for reducing retting time within 14 days. When considering physical requirements of coir, Treatment combinations 50% of nutrient media, 3 L/min air volume with pH 9 and 75% of nutrient media, 3 L/min air volume with pH 9 give estimated results within 14 days of coir retting. Treatment combinations, 50% of nutrient media, 3 L/min air volume with pH 7, 75% of nutrient media, 3 L/min air volume with pH 7, 50% of nutrient media, 3 L/min air volume with pH 9 and 75% of nutrient media, 3 L/min air volume with pH 9 give relatively higher results for average total colony count and colony forming units within 14 days of coir retting.

References

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