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Effect of Treatments on Coir Fibre

V. Thanabal[1], T. Gokul[2], K. Gowtham[3*], P. Hem Aswath[4]

[1,2,3,4]Department of Textile Technology, Bannari Amman Instiute of Technology, Erode, India

***Abstract*: This project investigated the effect of using cellulase enzyme, sodium hydroxide & hydrogen peroxide under specific treatment conditions, on the physical characteristics of coir fibres. Coir is ligno cellulosic fibre and is a coarser variety of seed fibre having some inherent advantages, namely agro-renewability, biodegradability, good tensile strength and modulus, high moisture regain and good dye bility. It has wide applications in home textiles, floor coverings, composites and geotextiles. However, this fibre has some inherent drawbacks such as stiffness, harshness, mesh structure with variable fibre length and branching, due to the presence of lignin. These drawbacks are chiefly responsible for its low spinnability, thereby limiting its applications. The physical characteristics such as tenacity, elongation, bending length and weigh loss after each treatment were studied. Tensile characteristics of these enzyme, alkalis, peroxide treated coir fibres in terms of tenacity (Mpa) were found to decrease by approximately 8.19%, 20.1% and 33.4% for cellulase enzyme treatment and, 6.64%, 16.26% and 32.18% for NaOH, 12.1%, 26.1% and 40.08% for hydrogen peroxide at 5%,10% and 20% concentration levels, respectively.**

***Keywords*: Coir fibre treatment, enzyme treatment, acid treatment, weight loss, reduce lignin content.**

1. Introduction

Coir is a natural fibre which is extracted from the husk of the coconut. There are two types of coir fibre white from the immature green coconut and brown from mature coconut. It is the coarser fibre among the all-natural fibers. One of the main advantages of coir is low decomposition rate; the strength of coir fibre is main reason for wide application. It is the one of the most lignin rich well known as a lignocellulose fibre. Due to larger composition of lignin in coir makes it more brittle and very hard makes spinning of fibre rather difficult. So to improve the flexibility of coir fibre various treatments has been involved in this study. In all these treatment techniques flexibility of coir fibre increased to some extent as its tensile strength decreases.

A. Coir fibre

Coir fibre is the one of the most lignin rich natural fibre. It is a ligno-cellulosic fibre. They possess high weather resistance due to higher amounts of lignin. They absorb water to a much lower extent when compared to other all natural commercial fibres due to lower composition of cellulose. They can be more stretched beyond their elastic limit without any break due to arrangement in helical angle of micro fibrils at 45^0. The cross sectional and longitudinal views are shown below, from the cross sectional views of coir fibre shows there are lot of cavities inside the fibre and 1/3rd of the bulk of fibre is filled by air. This entrapped air gives resilience of the fibre, its buoyancy in water, so, thereby increasing time taken to penetrate water into the fibres. The properties of coir fibers are less affected by wet conditions than other hard fibers. The main limitation of coir fibre is its being a very coarser and heavier.

Table 1
Fibre

Property	Values
Fibre diameter(mm)	0-260
Density(g/cc)	1-40
Water absorption (%)	40
Fibre length(mm)	Up to 150
Specific gravity	1-15
Young's modulus(GN/m^2)	4-5
Extension at break (%)	29-13
Tensile strength(MPa)	135-240
Breaking elongation (%)	30
Moisture regain 65% RH (%)	10.5

B. Fibre Properties (quality)

The different fibre extraction processes yield different but also varying qualities of fibres: generally 56-65 per cent long fibres of over150 mm (up to 350 mm staple length) and 5-8 per cent short fibres of fewer than 50 mm. The fibre fineness varies between 50 and 300 µm. The fibres are composed of individual fibre. Cells of about 1 mm length and 5-8 µm diameters. The tensile strength of coir is relatively low when compared to sisal or abaca fibres, but it is less impaired by immersion in water. Coir fibre has the advantage of stretching beyond its elastic limit without rupturing, as well as having the power to take up a permanent stretch. Its resistance to microbial degradation and salt water is unique. The important composition of coir fibres are cellulose (21%-40), lignin (16%-48%), and hemicellulose (13%-28%). Coir fibres contain relatively low amounts of cellulose (35 per cent) but have high lignin content (32 percent). This exceptionally high lignin content implies that the available dyeing and bleaching techniques for textile fibres cannot simply be transferred to coir.

C. Coir Fibre Treatments

Coir is an important ligno-cellulosic fibre due to its high level of moisture absorption characteristic and poor wettability, insufficient adhesion between the fibres. In order to improve above qualities adequate surface modifications are done.

D. Enzyme Treatment

One of the most common and wide used wet processing

*Corresponding author: gowtham.tx17@bitsathy.ac.in

techniques is enzyme treatment in textile industry. These technologies help to improve handle, appearance and other surface characteristics of coir fibres. Hydrolysis of cellulose with cellulase is used for bio polishing. Cellulases are hydrolytic enzymes that change state of breakdown of polyose to smaller oligosaccharides and at last aldohexose. Currently, additionally to biostoning, cellulases also are wont to method cotton and different cellulose- based fibres. Cellulases hydrolyze the microfibrills (hairs or fuzz) jutting from the surface of yarn as a result of their most liable to catalyst attack. This weakens the microfibrills that tend to interrupt aloof from the most body of the fibre and leave a drum sander yarn surface.

E. Alkali Treatment

Coir fibres are treated by sodium hydroxide (NaOH) solution with varying concentration from 2% to 20%. Before and after consequent treatment tensile characteristics have been measured. A decreased series of the fibre tensile strength with increased NaOH density were seen. In comparison to the cases of 2%, 4 %, 6 %, and 8 %, the cumulative tensile strength was lower in the case of NaOH density of 10%. This showed that the degradation of the fibres in the 10% case was serious. There was no discernible difference in composite tensile strength between the 2%, 4%, 6%, and 8%. The impurities in the coir fibre, such as pectin, fats, and lignin, will be removed with an alkali treatment. On the other hand, the treatment can result in a rougher fibre surface. These would strengthen the coir fiber's adhesive properties. According to the findings, higher alkali concentrations deteriorate fibre quality and the higher the concentration, the more damage to the fibre. When the alkali concentration was 10%, the loss of fibre strength may have played a significant role in the composite tensile strength.

2. Results and Discussion

A. Cellulase enzyme treatment

Table 2 Weight loss evaluation table for cellulase enzyme treatment

Concentration (%)	**Before treatment weight in gms**	**After treatment weight in gms**	**% reduction /weight loss %**
5%	1.00	0.981	1.9
10%	1.00	0.957	4.3
20%	1.00	0.916	8.4

Table 3 Tensile characteristics between treated and untreated fibres

Concentration (%)	**Tensile Strength(Mpa)**	**% Decreased Strength**	**Elongation (%)**
Untreated fibre	300.1	------	16.2
5%	275.52	8.19	17.2
10%	239.66	20.1	18.4
20%	199.8	33.4	21.1

Table 4 Bending length of coir fibre before and after treatment

Concentration (%)	**Bending length (mm)**
untreated fibre	2.61
5%	2.23
10%	1.75
20%	1.13

B. Sodium hydroxide (naoh) treatment

Table 5 Weight loss evaluation table for alkali treatment

Concentration (%)	**Before treatment weight in gms**	**After treatment weight in gms**	**% Reduction /weight loss %**
5%	1.00	0.989	1.1
10%	1.00	0.966	3.4
20%	1.00	0.929	7.1

Table 6 Tensile characteristics between treated and untreated fibres

Concentration (%)	Tensile strength(mpa)	% Decreased strength	Elongation (%)
Untreated fibre	300.1	------	16.2
5%	280.15	6.64	17.2
10%	251.30	16.26	18.8
20%	203.51	32.18	20.9

Table 7 Bending length of coir fibre before and after treatment

Concentration (%)	**Bending length (mm)**
Untreated fibre	2.61
5%	2.31
10%	1.87
20%	1.31

C. Hydrogen peroxide (h2o2) treatment

Table 8 Weight loss evaluation table for hydrogen peroxide treatment

Concentration (%)	**Before treatment weight in gms**	**After treatment weight in gms**	**% reduction /weight loss %**
5%	1.00	0.989	1.1
10%	1.00	0.966	3.4
20%	1.00	0.929	7.1

Table 10 Tensile characteristics between treated and untreated fibres

Concentration (%)	**Tensile strength(mpa)**	**% Decreased strength**	**Elongation (%)**
untreated fibre	300.1	------	16.2
5%	263.52	12.1	17.2
10%	221.66	26.1	18.8
20%	179.80	40.08	20.9

Table 11 Bending length of coir fibre before and after treatment

Concentration (%)	Bending length (mm)
Untreated fibre	2.61
5%	2.01
10%	1.48
20%	0.87

D. Weight loss graph

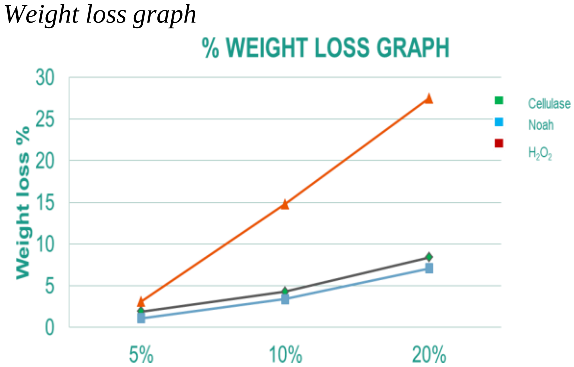

Fig. 1. Weight loss graph between treatments

E. Tensile strength graph

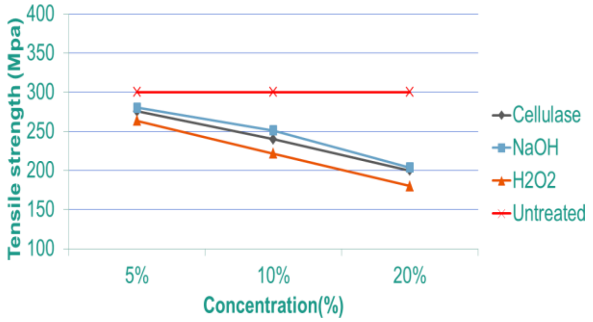

Fig. 2. Comparison between treated and untreated sample for tensile strength

F. Elongation graph

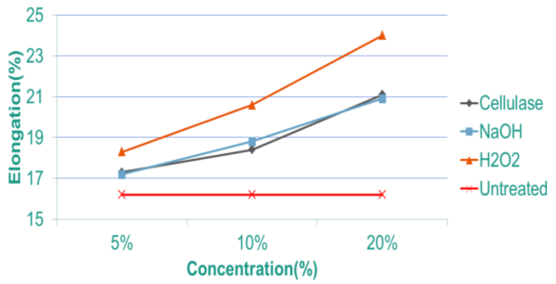

Fig. 3. Comparison between treated and untreated sample for elongation

G. Flexural rigidity or bending length graph

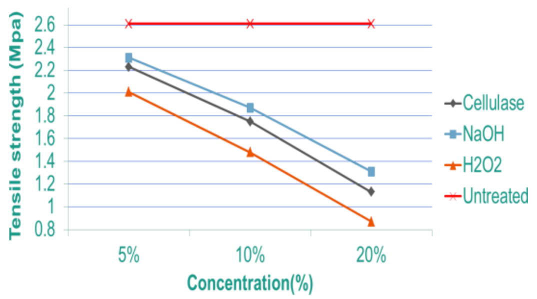

Fig. 4. Comparison between treated and untreated sample for flexural rigidity or bending length

3. Conclusion

Due to the presence of high quantity of lignin, coir fibre is very hard; the tensile strength of the coir fibre before and after the treatment is shown in Table 4,7,10. The findings showed that as the solution density increases, the fibre tensile strength decreases. The tensile strength gap between the groups was found to be important. The amount of lignin and pectin that leaches out increases as the chemical concentration rises. The Naoh treatment greatly decreases fibre strength due to the high pH level of Naoh. A rough fibre surface resulted from the alkali treatment. More and more Denser solution provided more + and ions to react with the substances on the fibre, causing greater amount of lignin, pectin, fatty acid and the cellulose to drain out, this would be detrimental to the fibre strength.

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