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# Effect of Concentration of NaOH & $H_2O_2$, M:L Ratio & Time on Scouring & Bleaching (Single Bath & Double Bath) on Jute Fiber.

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***ABSTRACT:*** *Sliver obtained from jute 3rd drawing frame was used for scouring and bleaching process to remove chemical impurities such as hemicellulose, wax and lignins. Caustic soda and Hydrogen peroxide were used as scouring and bleaching agents. The concentration, M:L ratio and time were varied in the scouring and bleaching process with a view to achieve a better removal of chemical impurities. The braking load of the fiber without any chemical treatment was 85-90 grams of single fiber but after chemical treatment the strength loss was observed and it was 15-20 grams which is about 20% of the original strength. The huge loss of strength indicates aggressive action of chemicals on fibers. The similar tendency was observed in the loss of fiber weight.*
***KEYWORDS:*** *Scouring, Bleaching, Jute Fiber, Single Bath, Double Bath*

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## I. INTRODUCTION

Ready-Made Garments are backbone of economy of Bangladesh. About 80% of total exports are done by this sector [1] through exporting the ready-made garments (RMG) to USA, EU, Canada and other countries.

Textile fibers are the Basic raw materials for the production of yarns in the spinning mills. Type of textile fibers includes raw Cottons, Polyester Staple Fibers (PSF), Acrylics, Wools, Silk, Flax, Viscose and others. Among those fibers, Cotton and Polyester Textile Fibers are the main two raw materials in Garments production. Consumption of cotton and polyester fibers are increasing day by day and whole textile world is heavily dependent on cotton and polyester fibers. Use of new fibers in the apparel industry is being seeking continuously by the textile experts.

As the requirement of fibers is being increasing in the apparel industry from year to year, supply of new or modified apparel fibers in the textile industry are demanding. From this concept, a new approach has been adopted in this study to utilize jute fibers in apparel. This study deals chemical treatment of jute fiber and the effect of the treatment followed by mechanical processing.

**Outline of this research:**

Long Jute Fibres
⇩
Processing of Jute Fibres up to 3rd Drawing Frame
⇩
Chemical Treatments of 3rd Drawn Sliver
⇩
Measurement of loss of Fibre Strength after each chemical treatment

Many researchers studied jute fibres on different aspects. K. Varma, R. A. Nanthak Krishnan, and S. Krishnamoorthy studied the Effect of Chemical Treatment on Mechanical Properties and Moisture Regain of Jute Fibers. They reported on the moisture regain, relative vapor pressure, hysteresis, and mechanical properties

of two varieties of jute fibers. *Corchoruscapsularis*grade 2 and *Corchorusolitorius*grade 2, modified by treatment with sebacoyl chloride, tolylenediisocyanate unsaturated polyester resin, vinyl ester resin, y-aminopropyl trimethoxysilane, and isopropyl tnisostearoyltitanate. All the treated fibers showed a reduction in moisture regain, but some fibers had superior moisture repellent behavior with no deterioration in their mechanical properties, while others suffered a loss in mechanical properties [2]. JochenGassan and Andrzej K. Bledzki investigated Alkali treatment of jute fibers: Relationship between structure and mechanical properties. They found that the mechanical properties of tossa jute fibers were improved by using NaOH treatment process to improve the mechanical properties of composites materials. Shrinkage of fibers during this process has significant effects to the fiber structure, as well as to the mechanical fiber properties, such as tensile strength and modulus. Isometric NaOH-treated jute yarns (20 min at 20°C in 25% NaOH solution) lead to an increase in yarn tensile strength and modulus of ∼120% and 150%, respectively. These changes in mechanical properties are affected by modifying the fiber structure, basically via the crystallinity ratio, degree of polymerization, and orientation (*Hermans factor*). Structure–property relationships, developed for cellulosic man-made fibers, were used with a high correlation factor to describe the behavior of the jute fiber yarns [3].

Dipa Ray and B. K. Sarkar studied the Characterization of alkali-treated jute fibers for physical and mechanical properties. Changes occurring in jute fibers when treated with a 5% concentration of a NaOH solution for 0, 2, 4, 6, and 8 h were characterized by weight loss, linear density, tenacity, and modulus, FTIR, and X-ray measurements. A 9.63% weight loss was measured during 2h of treatment with a drop of hemicellulose content from 22 to 12.90%. The linear density value showed no change until 2 h of treatment followed by a decrease from 33.0 to 14.5 denier by 56% after 6 h of treatment. The tenacity and modulus of the fibers improved by 45 and 79%, respectively, and the percent breaking strain was reduced by 23% after 8 h of treatment. X-ray diffractograms showed increase in crystallinity of the fibers only after 6 h of treatment, while FTIR measurements showed much of the changes occurring by 2 h of treatment with an increased amount of OH groups. By measuring the rate of change of the modulus, tenacity, and percent breaking strain with the time of treatment, a clear transition was apparent at 4 h of treatment with the dissolution of hemicellulose, causing a weight loss and drop in the linear density before and development of crystallinity with an improvement in the properties after the transition time [4].

Thermal Analysis of Chemically Treated Jute Fibers was investigated by S. N. Pandey, A. Day, and M. D. Mathew. They used DSC and TGA to study jute fibers treated with a flame retardant formulation, borax-formaldehyde-sodium hydrosulphite. DSC thermograms were obtained in both nitrogen and air atmospheres and TGA thermograms in nitrogen atmosphere. A thermal analysis was also made of fibers treated with borax alone. A comparison of thermograms for treated fibers with that of the control showed differences in the characteristic peak patterns due to the flame retardant treatment. The acquired flame retardancy of jute is explained on the basis of both the DSC and TGA analyses. A. B. Kundu, B. S. Ghosh, And S. K. Chakrabarti studied Enhanced Bleaching and Softening of Jute Pretreated with Polysaccharide Degrading Enzymes. Their report suggested that treating jute fibers with enzymes effects an increase in pore volume (46.2%), which leads to an increased capacity to retain peroxide (25.5%) and a larger surface area of lignin accessible to the oxidant (∼30%). Improved bleaching is therefore achieved. Enzyme treatment increases transverse swelling (14%) and reduces bulk torsional rigidity (12.5%), making the fibers more flexible and therefore softer. The removal of cementing materials such as hemicellulose and lignin by bleaching is enhanced by enzyme pretreatment, resulting in better filamentation and fineness. Scanning electron micrographs confirm this. Experiments with purified enzyme preparations have shown that xylanase pretreatment predominates in facilitating bleaching, and cellulase in the swelling or softening. An appropriate combination of the two is required to obtain optimal effects [5].

Leonard Y. Mwaikambo claims the effect of chemical treatment on the properties of hemp, sisal, jute and kapok for composite reinforcement The effect of chemical treatment on the properties of hemp, sisal, jute and kapok fibres for composite reinforcement Two chemical treatments were applied to hemp, sisal, jute and kapok natural fibres to create better fibre to resin bonding in natural composite materials. The natural fibres have been treated with varying concentrations of caustic soda with the objective of removing surface impurities and developing fine structure modifications in the process of mercerization. The same fibres were also acetylated with and without an acid catalyst to graft acetyl groups onto the cellulose structure, in order to reduce the hydrophilic tendency of the fibres and enhance weather resistance. Four characterization techniques, namely XRD, DSC, FT-IR and SEM, were used to elucidate the effect of the chemical treatment on the fibres. After treatment the surface topography of hemp, sisal and jute fibres is clean and rough. The surface of kapok fibres is apparently not affected by the chemical treatments. X-ray diffraction shows a slight initial improvement in the crystallinity of the fibres at low sodium hydroxide concentration. However, high caustic soda concentrations lower the fibre crystallinity. Thermal analysis of the fibres also indicates reductions in crystallinity with increased caustic soda concentrations and that grafting of the acetyl groups is optimised at elevated

temperatures. Mercerisation and acetylation have successfully modified the structure of natural fibres and these modifications will most likely improved the performance of natural fibre composites by promoting better fibre to resin bonding [6].

## II. MATERIALS AND METHODS

**Raw Materials:**
Bangla White (BWB) A-grade long jute fibres were selected as raw materials for this study. The raw materials were purchased from local market by the management of the Bangladesh University of Textiles.

**Chemical Used:**
Caustic Soda (NaOH), Bleaching Agent ($H_2O_2$), hydrogen Peroxide stabilizer, Wetting Agent, sequestering agent, Detergent are used in this experiment. All agents and chemicals collected from Delta Knitting Industries Ltd.

**Machine Used:**
We use the several numbers of machines in this experiment.

| | |
|---|---|
| Sample Dyeing M/C | : used for scouring and Bleaching of Jute fiber |
| Machine Capacity | : 10 gm |
| OD Batch Mixer | : Used to make jute fiber soft for subsequent processes. |
| Spreader | : Used to apply emulsion |
| Breaker Card | : Used to form of jute silver for finisher carding |
| Finisher card | : Used to make the sliver more uniform and regular in length and weight |
| First Draw Frame | : Used to make blending, equalizing the sliver and doubling two or more slivers |
| Second Draw Frame | : Used to make more uniform sliver and reduce the jute into a suitable size for third drawing |
| Third Draw Frame | : Used to make the sliver more crimped and suitable for spinning |
| Breaking Strength tester | : Used for strength test |
| Breaking Load tester | |

**Processing of Jute Fibres:**
The details of the jute spinning system are described below:

**Flowchart of Jute Spinning:**

Selection of Jute
↓
Softening & Lubricating
↓
Conditioning
↓
Breaker Carding
↓
1st Drawing Frame
↓
2nd Drawing Frame
↓
3rd Drawing Frame

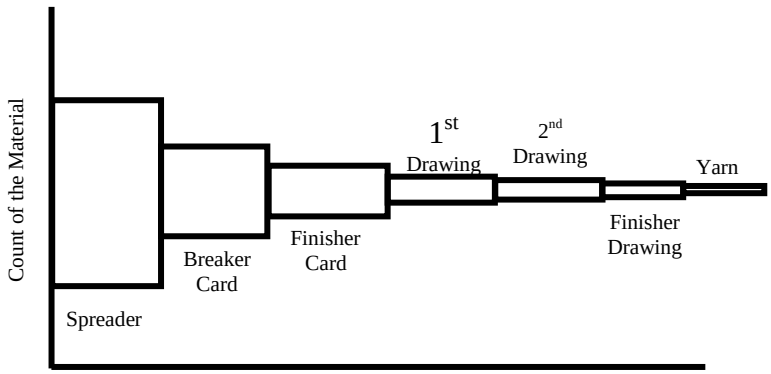


**Figure 1.** Relative counts in the jute process [7]

**Chemical Treatments of Jute Fibres:**
The produced 3rd drawn jute slivers were used for various chemical treatments.. Besides, we measured fibre strength of jute fibres before and after chemical treatments. At the same time fibre weight loss were also measured after different chemical treatment.

**Scouring Treatments:**
Jute fibre were treated in a single bath scouring and bleaching as well as double bath scouring and bleaching with a different concentration, liquor ratios, temperature and time to observe the best ever results. Finally silicone treatments were conducted on the best treated jute fibre. For both single bath and double scouring we used NaOH as a chemical agent. A wide variety of NaOH was used such as 5 g/L, 10 g/L, 15 g/L, 20 g/L and 40 g/L concentrations. Here, Material and Liquor ratio were 1:10 and 1:40 and temperature was 90℃. We run the machine for 30 min and 40 min to measure the impact of time variation.

**Bleaching Treatments:**
Again for both single bath and double scouring, we used different concentrations of $H_2O_2$ as a chemical agent such as 0.5 g/L, 1.0 g/L and 1.5 g/L. Here, Material and Liquor ratio were 1:10 and 1:40 and temperature was 90℃. similarly, we run the machine for 30 min and 40 min to measure the impact of time variation.

**Method of Measuring Mechanical Properties:**

**Determination of Fibre Weight:**
In this case, we cut jute fibre samples with scissor from 3rd drawn sliver. Then take the weight on the electric balance. After chemical treatment we also measure the samples fibre weight and recorded the weight variation.

**Determination of Breaking Strength**
Breaking load of the fibre were measured according to the Constant Rate of Loading (C.R.L.). To measure the fibre breaking strength, the fibre were hang from a fixed Jaw (Top jaw) and to another jaw which is movable. Then weight was added unless fibre breaks and recorded it.

## III. RESULTS AND DISCUSSION

**Effects of Single bath scouring of Jute fibre with Sodium Hydro-oxide (NaOH) :**
In order to obtain the optimum jute fibre quality with lower weight, the sodium hydroxide was used in different concentration such as 5g/L, 10g/L, 15 g/L, 20g/L and 40g/L where Material and liquor ratio varies for 1:10. The fibre samples were treated at 90˚for 30 min and 40 min, followed by washing and finally dried in an oven. After the treatment, the samples weight and Breaking Strength were tested to estimate the effect of sodium hydroxide concentration.

**Table 1.** Weight of fibre before and after NaOH treatment

| NaOH (g/l) | Without Treatment | M:L=1:10, Time 30 min | M:L=1:10, Time 40 min |
|---|---|---|---|
| 5 | 0.6 | 0.51 | 0.48 |
| 10 | 0.6 | 0.46 | 0.43 |
| 15 | 0.6 | 0.42 | 0.4 |
| 20 | 0.6 | 0.41 | 0.38 |
| 40 | 0.6 | 0.40 | 0.35 |

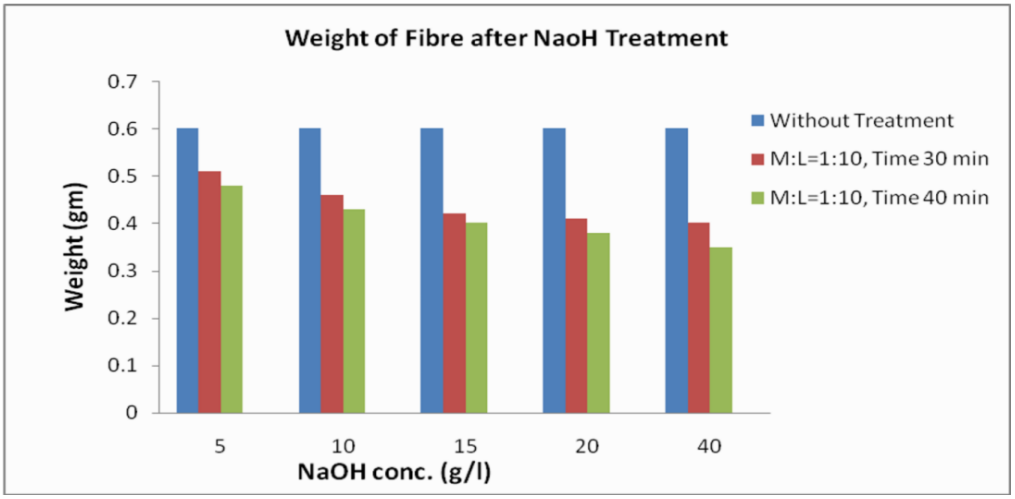


**Figure 2.** Fibre Weight Changes Due to Different NaOH Concentrations

About 30 – 40% sample fibre weight becomes less after NaOH treatment compared to 3rd drawn sliver (**Figure 2**). Most significant result is observed for M:L = 1:10 at 40 min. Although a higher fibre weight were recorded when it is treated with 15 g/L NaOH at M:L = 1:10 for 40 min. Others have shown a similar tendency to reduce the fibre weight after NaOH treatment.

**Effect of Scouring on Breaking Load with Various Concentration of NaOH, M:L Ratio & Time:**

**Table 2.** Breaking Load at different concentration of NaOH, M:L, Time at 90℃

| S/L | Concentration of NaOH (g/l) | Breaking Load (gm) | | | | |
|---|---|---|---|---|---|---|
| | | Without Treatment (gm) | M:L 1:10 | | M:L 1:40 | |
| | | | Time 30 Min | Time 40 Min | Time 30 Min | Time 40 Min |
| 1 | 5 | 85-95 | 45-55 | 25-30 | 55-60 | 20-25 |
| 2 | 10 | | 15-25 | 4.5-10.5 | 35-45 | 24-28 |
| 3 | 15 | | 10-15 | 3.5-4.5 | 20-30 | 15-20 |
| 4 | 20 | | 15-20 | 3.5-4.5 | 20-30 | 15-20 |
| 5 | 40 | | 8-15 | 3.5-4.5 | 15-20 | 10-15 |

Less breaking strength was found when Sample fibre was treated at a M:L = 1:40 for 30 min, though it is approximately 70% loss of the fibre strength (**Table 2**). Lower decrement was found when sample were treated at a M:L = 1:10 for 30 min, although about 50% fibre loss was recorded.

Only 4.5 – 10.5 gm weight was used to break the fibre after treated the sample fibre with 10 g/L NaOH at a M:L = 1:10 for 40 min. However, it required 35 – 45 gm weight to break the samples (**Table 2**).

Approximately 9 times fibre less strength is required to break the fibre after treating the sample fibre with NaOH at a M:L = 1:10 with 15 g/L NaOH concentration (**Table 2**). Here both the cases time differences has a less impact. When liquor ratio is higher thenfibre breaking strength remains higher compared to less liquor ratio. From the **Table 2**, it is clearly seen that 20 g/L NaOH has a similar impact on the fibre properties. Material and Liquor ratio has same tendency to reduce the breaking strength of the fibre whereas both the cases it remains

around 20 to 30 gm. 40 g/L NaOH has a huge impact specially for M:L = 1:10 at 30 min treatment (**Table 2**). Here lowest fiber breaking strength is 3.5 gm, similar tendency has seen for other cases.

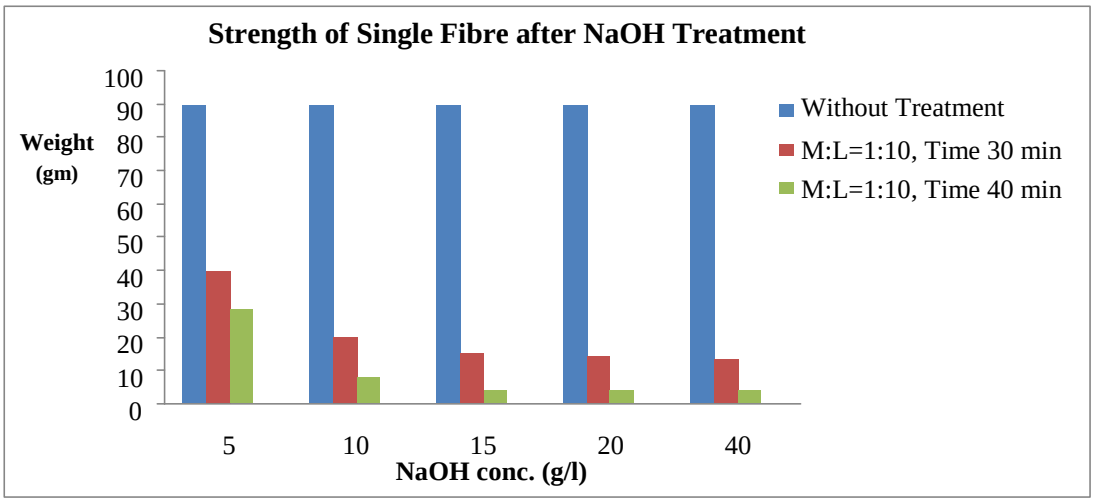


**Figure 3.** Single fibre strength after NaOH treatment at M:L 1:10

Lesser breaking strength was found when Sample fibre was treated at a M:L = 1:10 for 40 min, and concentration of NaOH was 40 g/L (**Figure 3**). Although a higher breaking strength was recorded when it is treated with 5 g/L NaOH at M:L = 1:10 for 40 min. Others have shown a similar tendency to reduce the breaking strength after NaOH treatment.

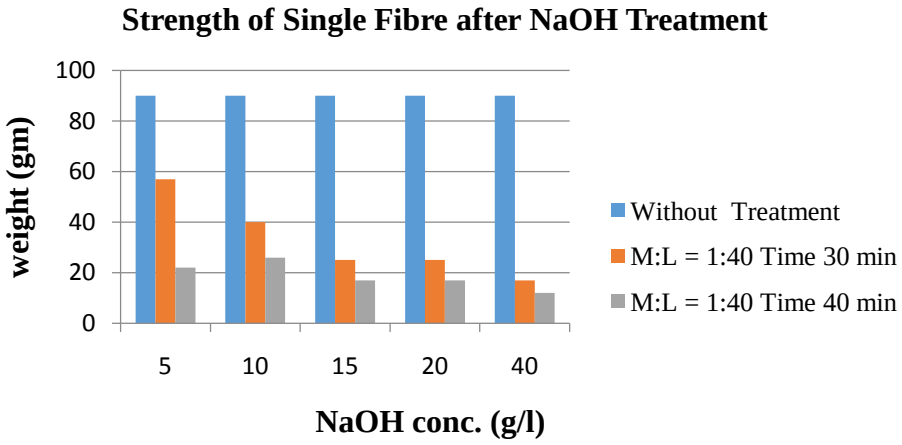


**Figure 4.** Single fibre strength after NaOH treatment at M:L 1:40

Lesser breaking strength was found when Sample fibre was treated at a M:L = 1:40 for 40 min, and concentration of NaOH was 40 g/L (**Figure 4**). Although a higher breaking strength was recorded when it is treated with 5 g/L NaOH at M:L = 1:40 for 30 min. Others have shown a similar tendency to reduce the breaking strength after NaOH treatment.

**Effects of Single bath Bleaching with different $H_2O_2$ concentrations:**

Different concentrations of $H_2O_2$ was applied for bleaching of the samples fibre such as 0.5 g/L, 1.0 g/L and 1.5 g/L where M:L = 1:40 and conduct fo 30 min and 40 min at a temperature of 90˚C. Finally washed and dried by using dryer and measured the after treated weight and breaking strength of fiber.

**Effect of fibre weight variation after $H_2O_2$ treatment:**

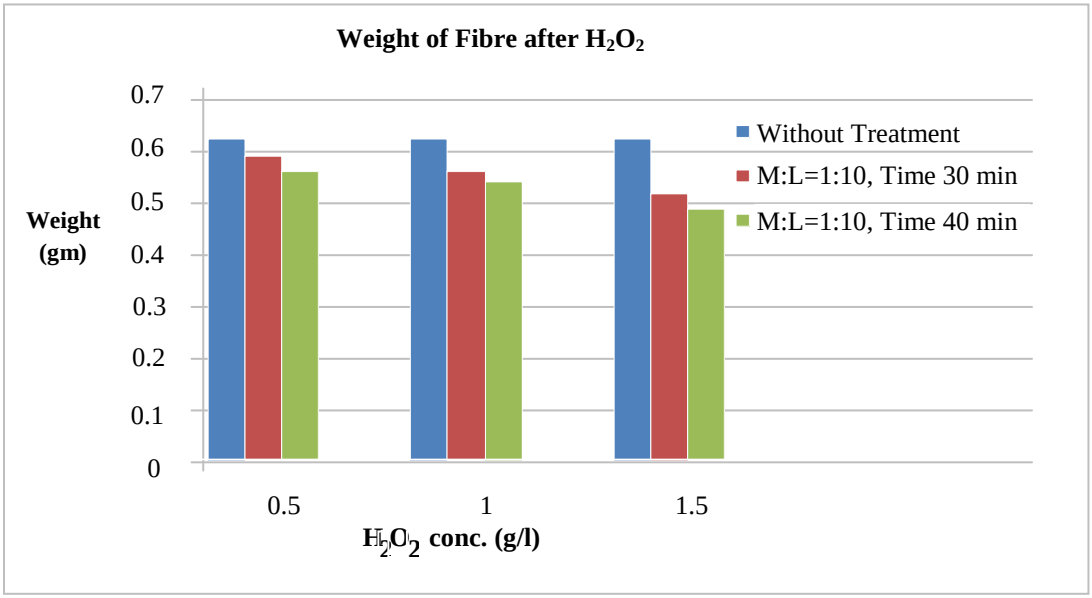


**Figure 5.** Fibre Weight Changes due to different $H_2O_2$ Concentrations

Form the **Figure 5**; we can see that there is a decrease of the fiber weight for all the cases of the treatment with $H_2O_2$ at different concentration and time variation. With the increase of $H_2O_2$ concentration, slight weight reduction of fiber is seen. When time of the reaction was increased at a same $H_2O_2$ concentration further weight reduction is also happened.

**Effect of Scouring on Breaking Load with Various Concentration of $H_2O_2$, M:L Ratio & Time:**

**Table 3.** Breaking Load at different concentration of $H_2O_2$, M:L, Time at 90℃

| S/L | Concentration of $H_2O_2$ (g/l) | Breaking Load (gm) | | | | |
|---|---|---|---|---|---|---|
| | | Without Treatment (gm) | M:L 1:10 | | M:L 1:40 | |
| | | | Time 30 Min | Time 40 Min | Time 30 Min | Time 40 Min |
| 1 | 0.5 | 85-95 | 15-25 | 15-20 | 20-28 | 15-25 |
| 2 | 1.0 | | 20-30 | 20-30 | 20-25 | 20-30 |
| 3 | 1.5 | | 25-35 | 25-30 | 30-35 | 30-40 |

Approximately breaking load reduced to 15 – 25 gm from 85 – 95 gm after $H_2O_2$ treatment for most of the cases except when M:L = 1:40 at 30 min (**Table 3**).

Though breaking load slightly increases compared with 1 g/L treated to 0.5 g/L (**Table 3**). All the cases breaking load were recorded approximately 20 – 30 gm.
When fibre were treated with 1.5 g/L $H_2O_2$ solution (**Table 3**) we found that only 25 – 30 gm weight is required to break the fibre when they are treated at a M:L = 1:10. Others required slightly higher load to break the fibre.

**Effect of Breaking Load of after $H_2O_2$ Treatment on Jute fibre:**

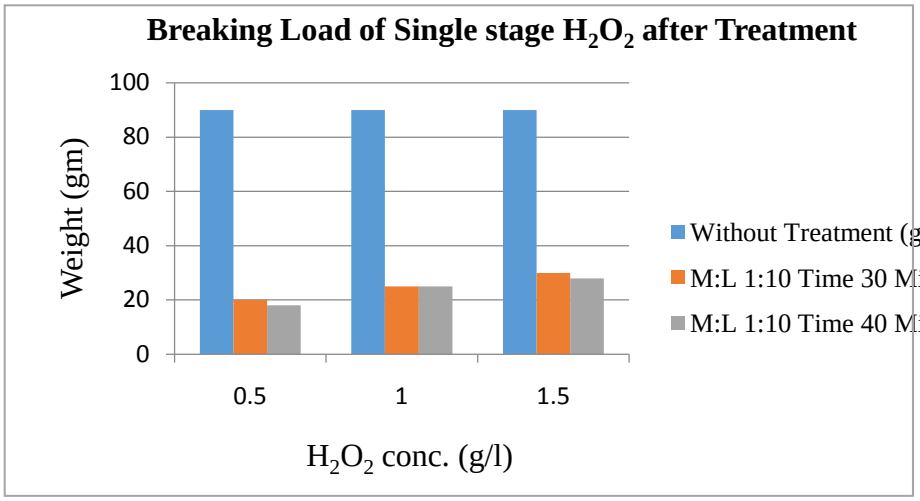


**Figure 6.** Effect of Breaking Load of after $H_2O_2$ Treatment on Jute fibre

**Effect of NaOH and $H_2O_2$ treatment on Jute fibre (Double bath Scouring and Bleaching):**
Here, 3rd drawn sliver of jute fibre were taken for double bath scouring and bleaching. Different chemical concentrations and material and liquor ratio was considered for the test.

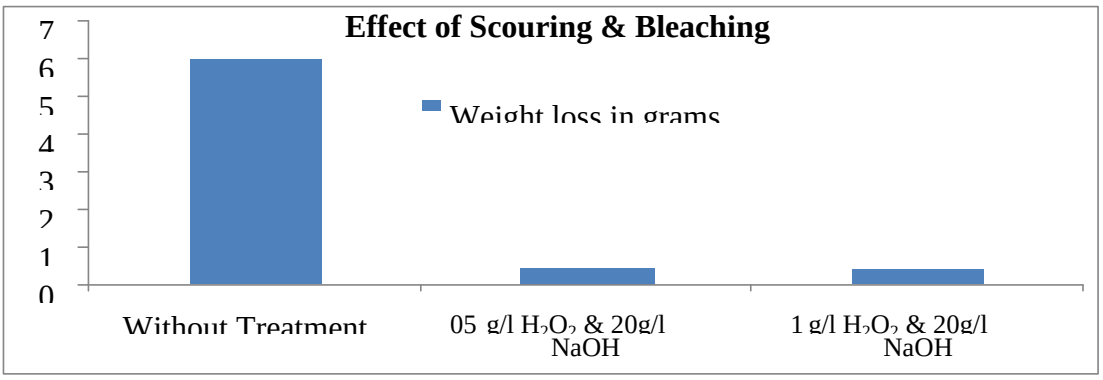


**Figure 7.** Effect of double bath scouring and bleaching on the fibre weight

From the **Figure 7**, approximately 20 – 30% fibre weight loss is recorded. Higher the $H_2O_2$ concentration, lower the fibre weight. About 0.40 gm fibre weight is recorded which is the lowest, though other samples has less around 0.50 gm after treatment.

**Table 4. Breaking Load at 90℃ and 40 min (Double Bath Scouring and Bleaching)**

| Breaking Load without chemical treatment | Breaking Load when M:L = 1:10 | | Breaking Load when M:L = 1:40 | |
|---|---|---|---|---|
| | 0.5 g/L $H_2O_2$ and 20 g/L NaOH | 1 g/L $H_2O_2$ and 20 g/L NaOH | 0.5 g/L $H_2O_2$ and 20 g/L NaOH | 1 g/L $H_2O_2$ and 20 g/L NaOH |
| 85 – 95 gm | 10 - 20 gm | 4 – 15 gm | 12 – 18 gm | 15 – 20 gm |

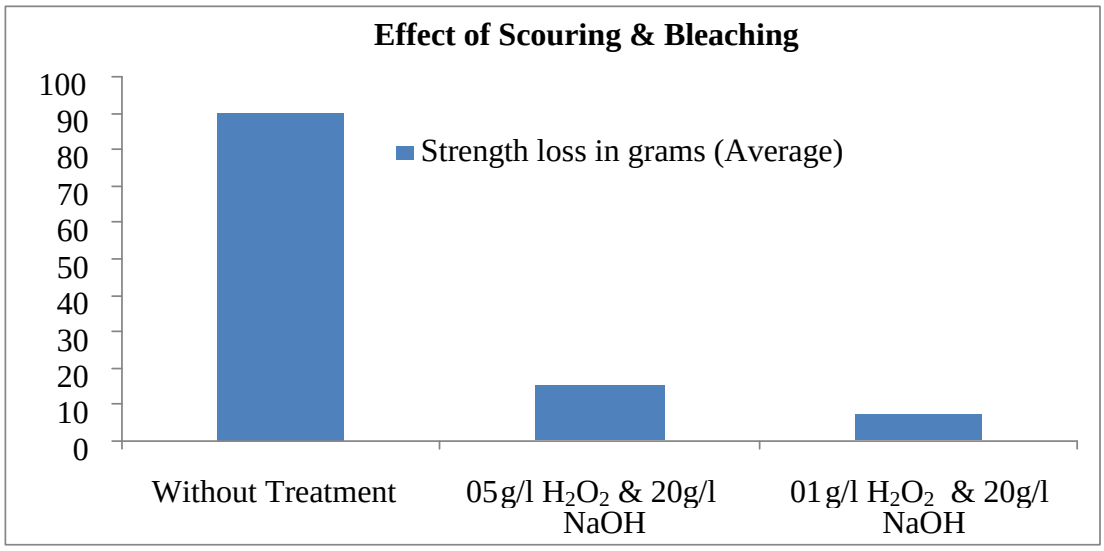


**Figure 8.** Effect of double bath scouring and bleaching on the single fibre strength

A double bath scouring and bleaching were conducted in a double bath. Here concentration of NaOH was 20 g/L fixed where $H_2O_2$ concentrations were varies (**Table 4**). We found that breaking strength is recorded at 8 – 15 gm which is less ever through others treatment. Interestingly, for all the other cases approximately 40 – 60% breaking strength reduced.

## IV. CONCLUSION

Long jute fibres were processed in the jute softener to remove lignin from the fibres to make them suitable for carding process. Two steps carding; Breaker and Finisher carding process were used to separate fibres entity. The card slivers were then passed through the jute drawing frames. 1st, 2nd and 3rd drawing farmes were used to make the fibres straight, parallel to each other and to get long spinnable fibres in sliver form.

The preparation of long jute fibers for the carding process has been done by the treatment in the jute softener to remove lignin from the fibers. Breaker and Finisher carding processes were employed to divide the fibers into different entities. After that, the card fragments were run through the jute drawing frames. First, second, and third drawing farms were utilized to straighten, parallelize, and get long, sliver-like spinnable fibers. Jute third-drawing frame sliver was used for the scouring and bleaching procedure to get rid of chemical impurities such hemicellulose, wax, and lignins. As scouring and bleaching chemicals, caustic soda and Hydrogen peroxide were employed. To improve the elimination of chemical contaminants, several combinations of concentration, M:L ratio, and duration were used throughout the scouring and bleaching process. The strength loss and breaking load have been observed in without any chemical treatment and after chemical treatment conditions. Abrasive chemical attack on fibers is the cause of the significant loss of strength. In the decline of fiber weight, a similar trend was observed.

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