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# EFFECT OF ENZYMATIC BLEACHING ON PHYSICAL PROPERTIES OF HEMP FABRIC

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***Abstract***

*Being an eco-friendly fiber, the use of hemp as a commercial textile fiber will be very beneficial. Therefore, the study was undertaken on the bleaching process of hemp fabric. The study observed the effect of chemical reagents as well as combinations of enzymes with chemicals on hemp fabric. The chemicals used were Hydrogen peroxide, Sodium hypochlorite, and Sodium hydroxide and six different combinations of chemical reagents and laccase enzyme (6 combinations i.e. Laccase + Hydrogen peroxide, Laccase + Sodium hypochlorite, Laccase + Sodium hydroxide, Hydrogen peroxide + Laccase, Sodium hypochlorite + Laccase, and Sodium hydroxide + Laccase) were used. The procured hemp fabric was tested for eleven physical parameters before and after processing. The hemp fabric bleached using chemical reagents only showed slight yellowing; hence these fabric samples were not used for further testing. The samples of chemical and enzyme combinations were used for further testing. Bleaching effect of all the samples was noted using spectrophotometer readings. The results showed that the readings of physical properties for fabric count, yarn crimp, yarn twist, thickness, weight per square meter, dimensional stability/shrinkage, crease/wrinkle resistance, tensile strength and tearing strength has increased after the treatment. There was very little change observed in the results of yarn count. The abrasion and pilling was reduced after the treatment. Among the bleached samples the highest whiteness was achieved with only laccase enzyme treated sample.*

***Keywords:*** *Hemp, Enzyme, Laccase, Physical test, Qualitative analysis.*



## Introduction:

Hemp is obtained from the bast of the plant, cannabis sativa. Cannabis Sativa is the plant that produces marijuana which is a hallucinogenic drug, due to which, for common people hemp was a controversial fibre. Hemp does not demand for any specific climate or soil. It grows very fast and the fibers are resistant to pests and herbicides. Cultivation of hemp does not require any agrochemicals and makes them Eco - Friendly. Large amount of carbon is captured by this plant thereby contributing to a healthy environment.

Europe which imports all natural fibres form different continents leaving hemp and flax, showed the capacity to develop the hemp fiber which has led to the research in the technical and marketing aspects of hemp as a renewed source of textile fibres. After the Second World War the introduction of chemical fibers had an influence on the total textile fibre situations where the natural fibres (Flax, Hemp, Wool and Silk) were eliminated from the textile products since the chemical fibres were cheap, simple and used efficient production technology along with good quality. After replacing the chemical fibers with natural fibers for a long period of time, today it is considered as an inferior quality as compared to that of natural fibre which have physiological, hygienic, health properties, comfort and ecological properties. Awareness has developed over the years that the total substitution of natural fibres by synthetic fibres is not desirable and has led to an unexpected return of natural fibres, including Hemp.

**Materials and Methods:**

Qualitative analysis of the fabric was done to ascertain the fiber content. Testing of physical properties of the fabric was done before and after the treatment of the fabric. The tests were repeated after the treatment to ascertain the changes in physical properties like: Fabric count (IS 1963:1981), yarn crimp (IS 3442:1980), yarn twist (IS 832:1985), thickness (IS 7702:1975), yarn count, weight per square meter (IS 1964:1970), dimensional stability (IS 9:1982), abrasion (IS 12673:1989), crease resistance (IS 4681:1981), tensile strength (IS 1969:1985), tearing strength (IS 6489:1993/ISO 9290:1990). Enzymatic bleaching of hemp was done with the use of chemicals along with enzymes to ensure better results. The variations that were created are:

1. H2O2 + Laccase
2. NaOH + Laccase
3. NaOCl + Laccase
4. Laccase + H2O2
5. Laccase + NaOH
6. Laccase + NaOCl

In the above mentioned first three variations, the samples are first treated with the chemical reagent followed by a treatment with Laccase enzyme, while in the remaining three samples, a treatment with laccase enzyme is conducted first, followed by a treatment with the chemical reagent. However, the difference being, the quantity of chemical reagent used is far lesser than the quantity used in a conventional chemical treatment.

## Results and Discussion

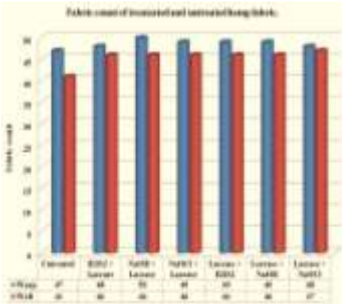

**Fig. No. 1 Fabric count: comparison between treated and untreated hemp fabric**

Fig.No. 1 shows the results of fabric count before and after treatment, there is a marginal increase in the fabric count of treated fabric. The maximum values in the warp can be seen in NaOH + Laccase treated sample, however the change in values is minimal. A higher percentage increase can be noted in the fabric count for the weft direction. The increased values are similar for all the treated samples except Laccase+ NaOCl where it is the highest.

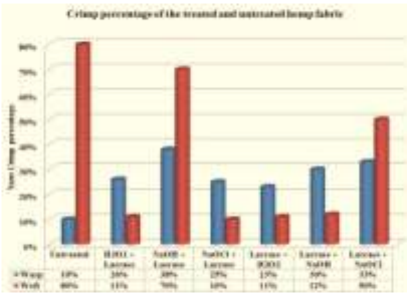

**Fig. No. 2 Yarn crimp: comparison between treated and untreated hemp fabric**

Fig. No. 2 shows that, the yarn crimp for warp has increased after the treatment while the yarn crimp for weft has decreased after the treatment. It can be attributed to the changed values of the fabric count after the treatment. There is only a marginal increase in the warp direction whereas there is a higher increase in the fabric count in the weft direction. Increase in the count in the weft direction may have contributed to reduction in crimp in the same direction.

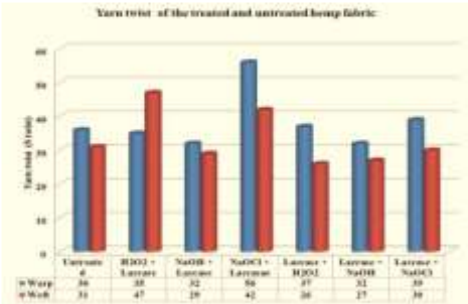

**Fig. No. 3 Yarn twist: comparison between treated and untreated hemp fabric**

The figure above shows that higher amount of twist is observed in NaOCl + Laccase sample for warp direction and higher amount of twist for weft is observed in H2O2 + Laccase and NaOCl + Laccase.

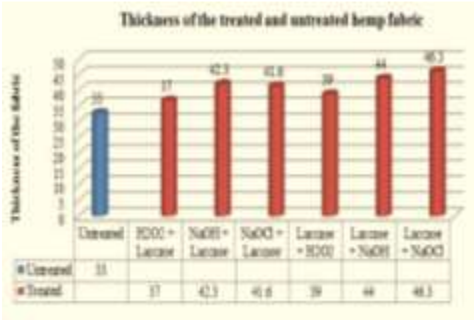


**Fig. No. 4 Thickness test: comparison between treated and untreated hemp fabric**

Fig. No. 4 represents the results of fabric thickness.  It shows that there is an increase in the thickness of the fabric after the treatment.  The fibers in the treated fabric samples may have been swollen due to the chemical / enzyme treatments that have been imparted to the same. Highest value for thickness can be seen in Laccase +NaOCl treated sample.

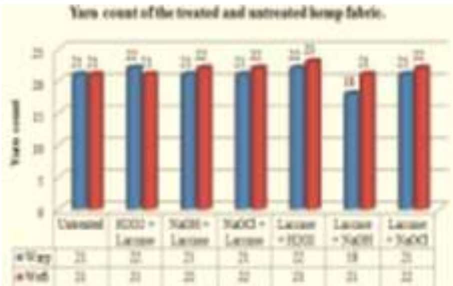


**Fig. No. 5 Yarn count: comparison between treated and untreated hemp fabric**

The results of yarn count are depicted in Fig. No. 5.  It shows the yarn count values have change minimally for both warp as well as weft. However, it can be noted that the Laccase +H2O2 treated sample shows maximum increase in values in both the directions, while the values for Laccase + NaOH treated sample have reduced in the warp direction.

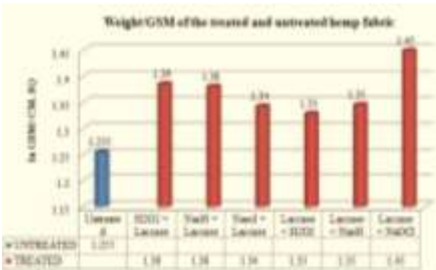

**Fig. No. 6 Fabric weight: comparison of GSM of treated and untreated hemp fabric**

Fig. No. 6 shows that, the GSM of the fabric has increased after the treatment. This can also be co-related with the increased thickness of the treated samples. It can be noted that the maximum values for thickness have been obtained for Laccase + NaOCl and a similar change has been observed in the same sample for its weight.

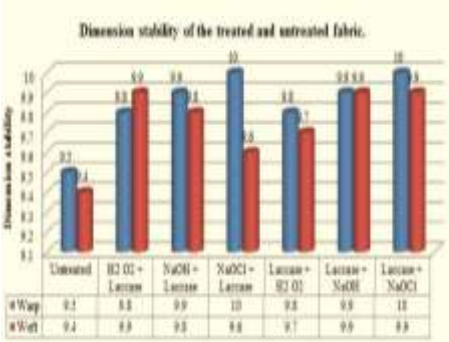


**Fig. No. 7 Dimensional stability: comparison between treated and untreated hemp fabric**

The figure above shows that, the shrinkage of the fabric has decreased after the treatment. In the NaOCl + Laccase and Laccase + NaOCl samples, it can be noted that there is neither shrinkage nor elongation in the warp direction of the fabric. In all the other samples there is minimal shrinkage in both the directions except NaOCl + Laccase and Laccase + H2O2 where there is higher shrinkage in the weft direction as compared to the other samples. The change in the change in the readings before and after can be attributed to the enzyme / chemical treatments carried out on the fabric.

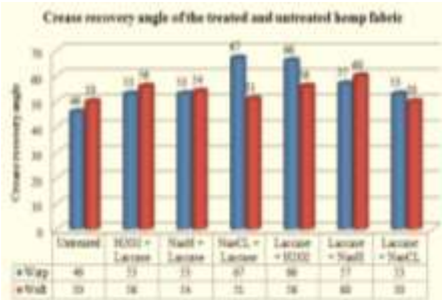


**Fig. No. 8 Crease recovery: comparison between treated and untreated hemp fabric**

The results of crease recovery angle can be noted from Fig.No. 8. It shows that, the crease recovery angle has increased in both the warp as well as weft. This change may be because some of the lignin may have got dissolved in the enzyme / chemical treatment. Highest values for crease recovery in warp and weft can be noted in NaOCl + Laccase and Laccase + NaOH respectively.

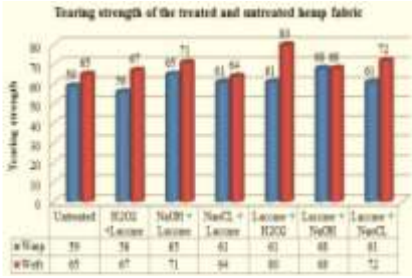


**Fig. No. 9 Crease recovery: comparison of treated and untreated hemp fabric**

Fig. No. 9 shows that, the tearing strength has increased in all the samples except H2O2 + Laccase and NaOCl + Laccase in its warp and weft direction respectively. All the other samples show an increase in the tearing strength values in both the directions. The highest values can be noted in Laccase + NaOH and Laccase + H2O2 in warp and weft direction respectively.

**Fig. No. 10 Whiteness index of treated and untreated hemp fabric.**

1. It is interesting to know that the samples created with chemicals only i.e. H2O2, NaOH and NaOCl reduce the whiteness of the fabric. NaOCl values are almost similar to the values of the original untreated fabric. Slight yellowing of sample is seen with H2O2 and NaOH.
2. In the samples created with variation in combinations of commercial chemical reagents and laccase enzyme, the combinations of commercial chemical reagents and laccase enzyme has shown more prominent results as compared to that of only with commercial chemical reagents and laccase + commercial chemical reagents. The maximum whiteness index is seen for laccase + NaOCl and NaOCl +Laccase sample. The second highest reading is seen in the NaOH + Laccase and H2O2 +Laccase sample. The least action is seen with NaOH and Laccase + NaOH.

| | Untreated | $H_2O_2$ + Laccase | NaOH + Laccase | NaOCl + Laccase | Laccase + $H_2O_2$ | Laccase + NaOH | Laccase + NaOCl |
|---|---|---|---|---|---|---|---|
| 500 Cycles | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface | Short fibres protruding out from the fibre surface |
| 1000 Cycles | More short fibres protruding out | Tear | Tear | More short fibres protruding out with 3 - 4 Pills | More short fibres protruding out | More short fibres protruding out with 2 - 3 Pills | More short fibres protruding out with 2 - 3 Pills |
| 2000 Cycles | More short fibres protruding out with moderate pilling | | | More short fibres protruding out with 2 pills | Tear | Tear | Tear |
| [illegible] | No change | | | Tear | | | |

**Fig. No. 11 Abrasion / pilling: comparison between treated and untreated hemp fabric.**

In Fig. No. 11, it was noted that the abrasion / pilling cycles was reduced after the treatment except or NaOCl + Laccase which can withstand up to 2000 cycles while the least amount of resistance towards abrasion / pilling can be seen for $H_2O_2$ + Laccase and NaOH + laccase which are resistant to abrasion / pilling up to 500 cycles only.

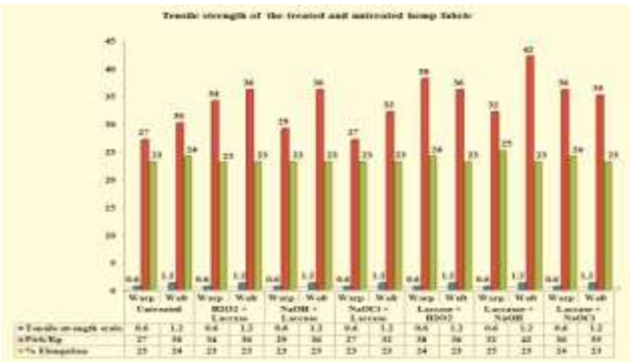


**Fig. No. 12 Tensile strength: comparison between treated and untreated hemp fabric.**

It can be observed from Fig. No. 12, that the tensile strength has increased in all the samples except the percentage elongation which is showing a minimal increase throughout respectively. The highest value is observed in Laccase + NaOH towards picks per KG in weft direction. The second highest values are seen in Laccase + $H_2O_2$ picks per kg in warp direction. There is not much change observed for percentage elongation. The highest value for elongation can be seen in warp direction for Laccase + NaOH.

**Conclusion**

Enzymatic bleaching has shown good results towards all the chemical – enzyme combination bleaching process as compared to that of bleaching with only chemical reagents, with the highest values for Laccase + NaOCl and NaOCl + Laccase sample and the least value is seen for the NaOH and Laccase + NaOH.

The results of the physical properties show positive results for fabric count, yarn crimp, yarn twist, thickness, and weight per square meter, dimensional stability/shrinkage, crease/wrinkle resistance, tensile strength and tearing strength after the treatment. There is very negligible change observed for yarn count. The abrasion and pilling was reduced after the treatment. Hence the benefits of enzymatic bleaching over regular processing can be viewed as:

1. It saves energy as well as chemicals that effect the environment.
2. Energy saving as it requires less temperature for processing.
3. The improvement in the properties from the original sample is noted.

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