Effect of Copper Oxide Nanoparticles synthesized from Chemical Precipitation Method (In-situ) on the Mechanical Properties of Sansevieria Trifasciata Fiber extracted from Sansevieria Trifasciata Plant

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Abstract

Sansevieria Trifasciata Plant was chosen for the study. The cellulosic Fiber was extracted by using retting technique of Fiber Extraction. Copper Oxide Nano Particles were applied on Sansevieria Trifasciata Fiber (STF) through In-situ method of Chemical Precipitation Process. The structure and morphology of the coated and un-coated STFs were examined by X-ray diffraction (XRD) and Field Emission Scanning Electron Microscopy (FESEM). These tests were performed in Sophisticated Analytical Instrument Facility, Panjab University, Chandigarh. These methods revealed that CuO Nano Particles are crystalline in nature and are absorbed onto the surface of STFs. The mechanical properties namely Breaking Strength, Tenacity and Elongation of uncoated and nanocoated STFs were evaluated. These tests were conducted in Northern India Textile Research Association. Results showed the changes in Breaking Strength and Tenacity which decreased whereas Elongation of the coated STF showed an increase after the application of Copper Oxide Nano Particles via In-situ Method of Chemical Precipitation Process.

Keywords: *Sansevieria Trifasciata Fiber, Breaking Strength, Tenacity, Elongation*

1. Introduction

Nanotechnology is already a well-known science which takes advantage of novel properties of atoms and molecules at the dimensions of nanometer scale with 1 nanometer (nm) being equal to 10^{-9} meter. Such materials exhibit extraordinary optical, mechanical, thermal and electrical properties which are quite distinct from the ordinary materials [1]. These properties are mainly due to high surface area to volume ratio of Nano Particles and the quantum-mechanical effects at nano scale.

Textiles are an integral part of our life with their everyday use in clothing, furnishing, house wares, and technical applications including smart textiles in electronics and biomedical sectors. Conventional methods for imparting different properties to textile fabrics are not suitable for inducing long-lasting durability, and the fabrics so prepared are most often seen to lose the induced properties after wearing and a few cycles of washing. Nanotechnology has emerged as a new process of preparing highly durable fabrics with never imagined properties or functionalities such as self-cleaning, fire-resistance, protection towards ultra-violet(UV) radiation, anti-bacterial, abrasion resistance, resistance to chemicals, water and dirt repellence, high tensile strength, soft surface, durability, to name a few.[2]

The environment is endued with indispensable fiber yielding plants which have extensive prospective for use in various fields, but a lot of them have remained unchartered so far. [3]Various viewpoints regarding exploring novel benefits from organic products of plant origin remain the stockpile for new investigation and development. The present research is based on the extraction of fibers from Sansevieria Trifasciata Plant and application of Copper Oxide Nano Particles on these fibers with following Objectives:

1.1 Objectives:-

1.1.1 Extraction of natural cellulosic fibers from the leaves of Sansevieria Trifasciata Plant and testing its mechanical properties.

1.1.2 Application of Copper Oxide Nano Particles on these fibers by In-Situ Chemical Precipitation Method.

1.1.3 Investigation of Characterization of Nano Particles on STF through FESEM and XRD

1.1.4 Comparative analysis of Mechanical properties of the fibers pre and post application of Copper Oxide Nano-Particles.

2. Methods

2.1 Extraction of fiber from Sansevieria Trifasciata Plant

Leaves of Sansevieria Trifasciata plant were dipped in a Tank of filled with water for about 25 to 30 days. When the leaves of Sansevieria Trifasciata plant were fully decomposed; residual gum and some impurities were separated out and fibers were extracted manually (Plate No. 2.1 a). Fibers were washed in clean water (Plate No.2.1 b) and dried out in shade to avoid bleaching. Proper drying was important as the moisture content in fiber could affect quality of the Sansevieria Trifasciata fiber. (Plate No. 2.1 c). The length of the Sansevieria Trifasciata Fibers was approximately 100 to 125cms long and they were beige in color.[4]

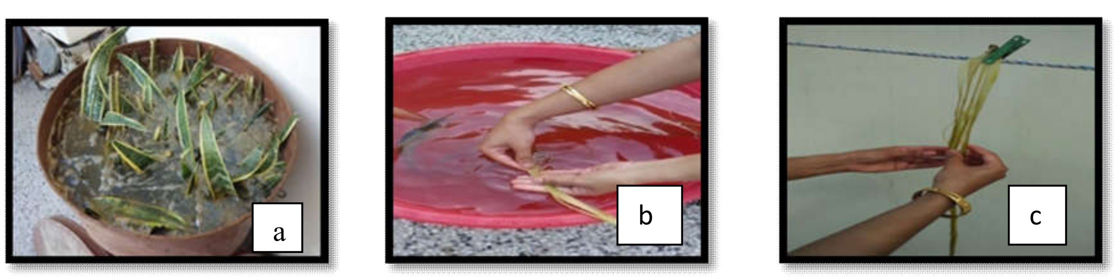


Plate No. 2.1(a,b & c) Process of Extraction of STF through Retting Technique

2.2 **Chemical Precipitation Method (In-situ)**

Copper Oxide Nanomaterials were synthesized by Chemical Precipitation Method. 10 Molar Copper Sulphate solution was prepared by adding 0.12 g Copper Sulphate in 90 mL of double distilled water. The precursor solution was then magnetically agitated for 10 minutes to obtain a clear solution to which 60 M Sodium Hydroxide (0.12 g in 10 mL) solution was added drop by drop. Sansevieria Trifasciata Fibers was then added to the solution. The resulting mixture (suspension and fibre) was kept under stirring for one hour. The mixture was then transferred in a Teflon lined stainless steel autoclave and heated at 60 degree Celcius for 24 hours. After cooling down to room temperature, the Copper Oxide Nanocoated Sansevieria Trifasciata Fibers were washed for 5– 10 minutes in distilled water in order to remove the weakly suspended particles.

2.3 Characterisation of Nanocoated Sansevieria Trifasciata Fiber

Morphology and dispersion of synthesized Copper Oxide Nanoparticles on coated fibers were investigated by a Field Emission Scanning Electron Microscopy (Fe-SEM, Plate 2.3a) and X-Ray Diffraction (XRD, Plate 2.3b) in Sophisticated Analytical Instrumentation Facility, Panjab University, Chandigarh.

Plate 2.3 a) FESEM Machine

Plate 2.3 b) XRD Machine

2.4 Testing of Nano Coated Fibers for its Mechanical Properties

Nanocoated Sansevieria Trifasciata Fibers were tested for Mechanical Properties including Breaking Strength, Tensile Strength and Elongation in Textile Testing laboratory of Northern India Textile Research Association in Ghaziabad. These properties were tested using Vibrodyne. (Plate 2.4)

Plate 2.4 Vibrodyne

2.5 Coding of Samples

Sansevieria Trifasciata Fibers were coded as Controlled Sample K and Copper Oxide Nanocoated Sample K1.

2.6 Analysis of Result: Pre and Post Application of Nano Particles on STF

Comparison of tests reports of pre and post application of Nano Particles on the fibers was made and conclusions were drawn based on results. One-way ANNOVA was applied on the results to draw conclusions.

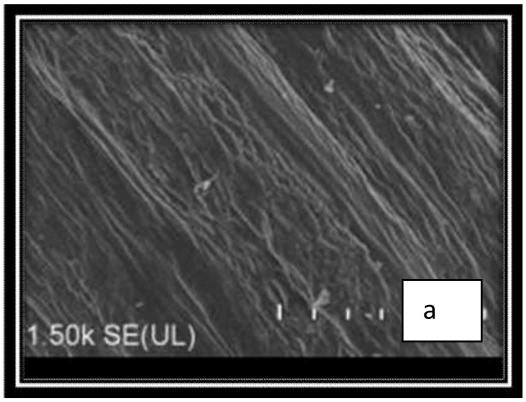
3. Results and Discussion

3.1 Extraction of Fiber from Sansevieria Trifasciata Plant and Testing Mechanical Properties of the same.

Sansevieria Trifasciata Plant was sourced from the parks of Sector 15, Panchkula. The leaves of the Sansevieria Trifasciata Plant were cut and stored in the store-room under normal room temperature. Water-retting technique was used to extract Sansevieria Trifasciata Fiber from the Sansevieria Trifasciata plant.[4] The leaves were dipped in water tank for about 25-30 days. When the leaves were completely degraded, all the gum and residue was manually removed from Sansevieria Trifasciata Fibers. The extracted Sansevieria Trifasciata fiber was beige in color and coarse in texture.

3.2 Investigation of Characterisation of Copper Oxide Nanoparticles (In-situ) on Sansevieria Trifasciata Fibers

3.2.1 Field Emission Scanning Electron Microscope images of uncoated and Nanocoated fibers



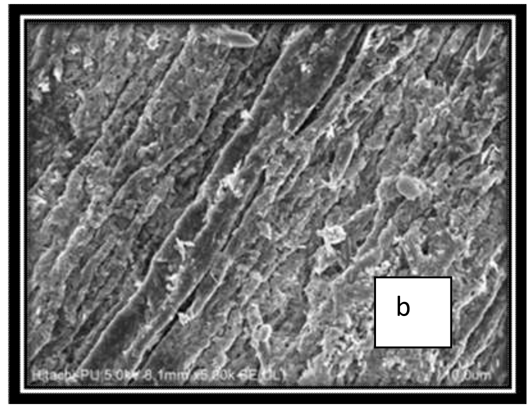
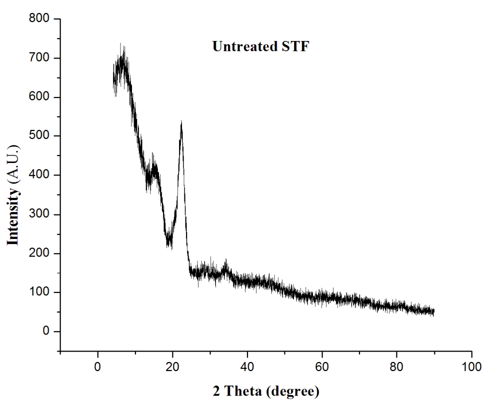


Plate No. 3.2.1a): FESEM Image of Untreated STF **Plate No. 3.2.1b): FESEM Image of Nanocoated STF**

3.2.2 X-ray Powder Diffraction of uncoated and Copper Oxide Nanoparticles (In-situ) coated fibers



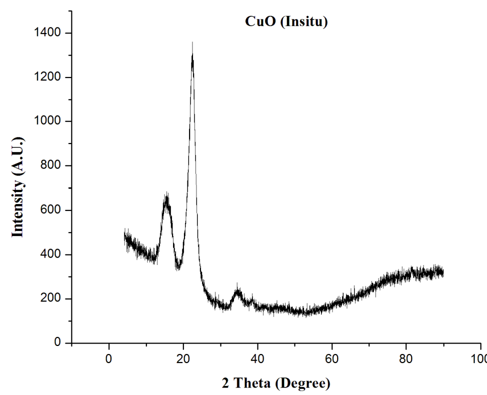


Fig. 3.2.2 a) XRD Pattern of Uncoated STF **Fig. 3.2.2b) XRD Pattern of Nanocoated STF**

The crystalline nature and single phase of Copper Oxide Nano Particles on Sansevieria Trifasciata Fiber was revealed by the presence of distinct peaks visible due to high intensity of X-ray Powder Diffraction of uncoated and Nanocoated fibers (Figure 3.2.2 a & b). The characteristic peaks of Copper Oxide coated Sansevieria Trifasciata Fiber occur at 22.6 and 34.660 which are designated to lattice planes 110, 200 and 111 respectively. [5]

The XRD diffractogram of Sansevieria Trifasciata Fiber supported the presence of Copper Oxide peaks thus confirming the presence of Nano Particles on STF surface.

3.3 Mechanical Properties of Sansevieria Trifasciata Fiber before and after application of Copper Oxide Nano Particles (In-situ)

3.3.1 Analysis of Breaking Strength of Sansevieria Trifasciata Fiber before and after application of Copper Oxide Nano Particles (In-situ)

Table 3.3.1 : Breaking Strength of Controlled Sample K and Test Sample K1

Test Parameters	Controlled Sample K	Test Sample K1
Breaking Strength (grams)	126.24	115.67

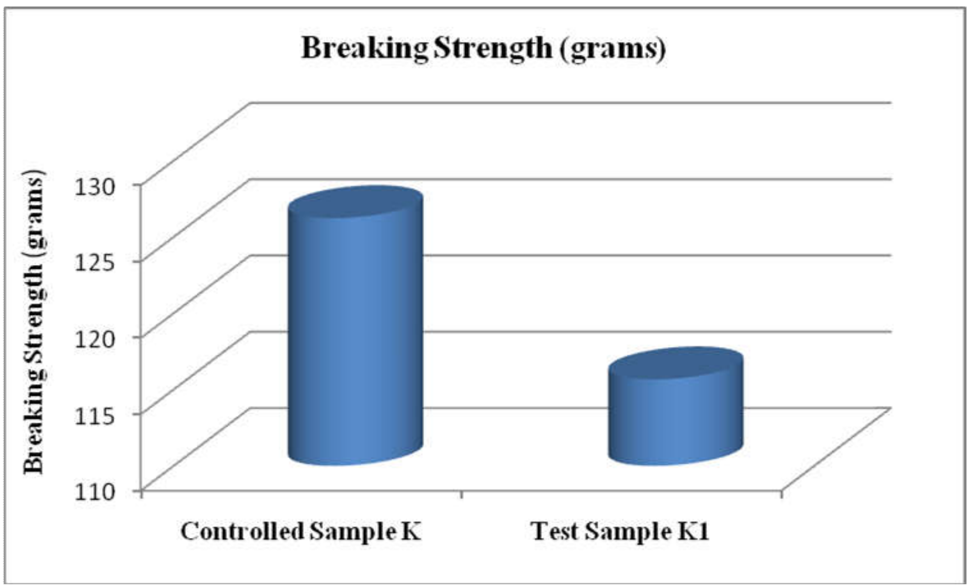


Fig.3.3.1: Change in Breaking Strength of STF

Table: 3.3.1(a) P-value for Breaking Strength of Copper Oxide Nanocoated STF (In-situ)

Breaking Strength								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Test Sample K1	15	115.6720	73.66344	455323.668	7	65046.238	6.829	<.001**

Controlled Sample K	15	126.2373	61.84119	1019243.617	107	9525.641		

Table 3.3.1 a) shows the difference between Breaking Strength of Controlled Sample K and Test Sample K1. Breaking Strength of Test Sample K1 has been found to significantly decrease at 1>0.001% level of significance. This indicates that application of Copper Oxide Nano Particles through In-Situ method of synthesis to the Sansevieria Trifasciata Fiber significantly affects the Breaking Strength of the Test Sample K1 thereby making it less durable as compared to Sample K. Table 3.3.1 shows the decline in breaking strength from 126.24 grams for Controlled Sample K to 115.67 grams of Test Sample K1. Introduction of Copper Oxide Nano Particles into the structure of fiber did not cause any improvement in the Breaking Strength of the fiber.

3.3.2. Analysis of Tenacity of Sansevieria Trifasciata Fiber before and after application of Copper Oxide Nano Particles (In-situ)

Table 3.3.2: Tenacity of Controlled Sample K and Test Sample K1

Test Parameters	**Controlled Sample K**	**Test Sample K1**
Tenacity (gram/denier)	3.40	2.11

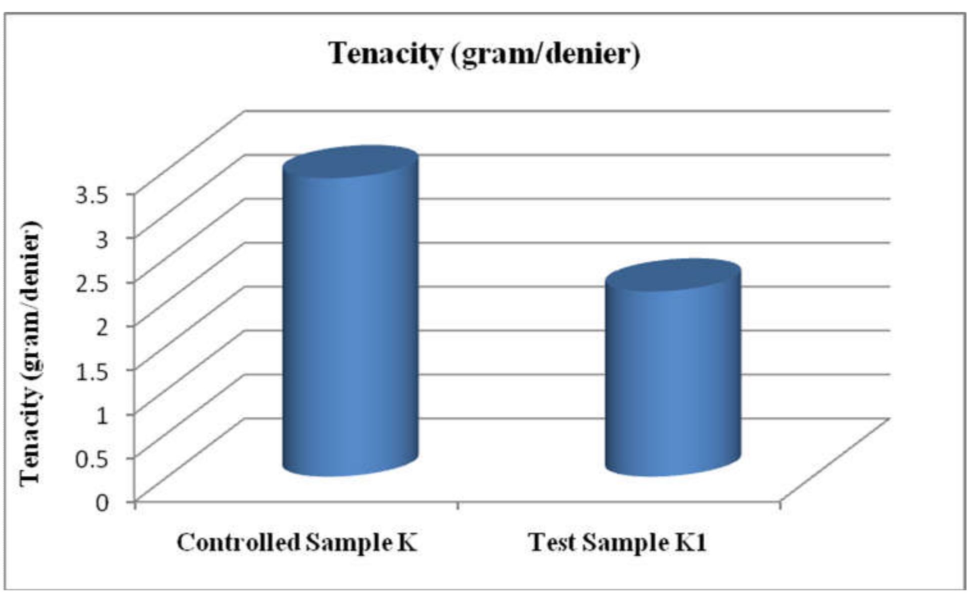


Fig.3.3.2 : Change in Tenacity of STF

Table. 3.3.2a): P-value for Tenacity of Copper Oxide Nanocoated STF (In-situ)

Tenacity								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Test Sample K1	15	2.1113	.94295	196.470	7	28.067	8.458	<.001**
Controlled Sample K	15	3.3953	1.17685	355.087	107	3.319		

Tenacity of the Sample K is 3.40 grams per Denier whereas Tenacity of Test Sample K1 is 2.11 grams per Denier as shown in Table 3.3.2. It may be due to lack of good orientation of Copper Oxide Nano Particles in Sansevieria Trifasciata Fiber.

Statistically, it can be stated from Table 3.3.2a) the difference between Tenacity of Test Sample K1 and Controlled Sample K was significant at 1>0.001 level of significance. This indicates a significant change in Tenacity of the Test Sample K1. Tenacity did not improve; rather it decreased as compared to Controlled Sample K.

3.3.3 Analysis of Elongation of Sansevieria Trifasciata Fiber before and after application of Copper Oxide Nano Particles (In-situ)

Table 3.3.3: Elongation of Controlled Sample K and Test Sample K1

Test Parameters	**Controlled Sample K**	**Test Sample K1**
Elongation at break (%)	2.93	3.05

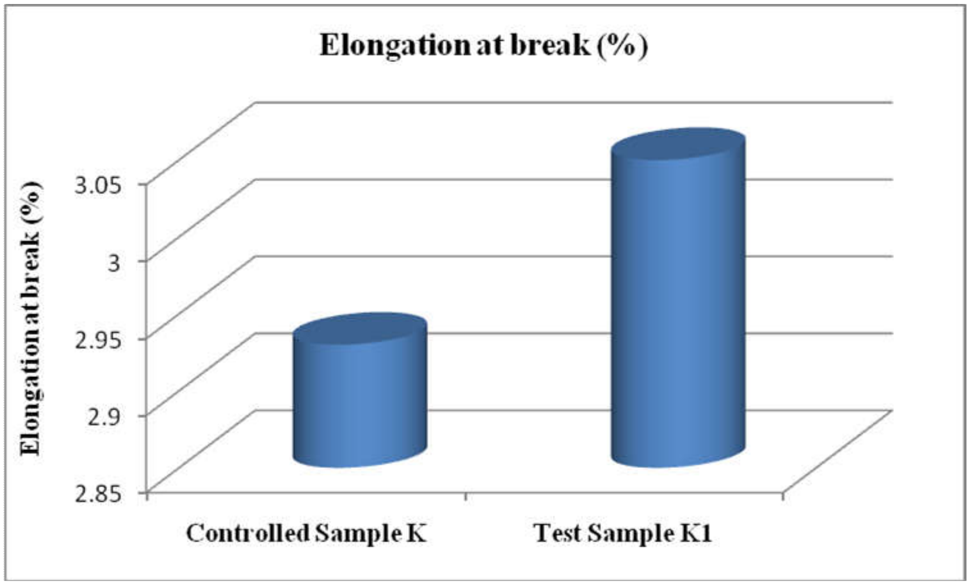


Fig.3.3.3 : Change in Elongation at break of STF

Table: 3.3.3 (a) P-value for Elongation of Copper Oxide Nanocoated STF (In-situ)

Elongation								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Test Sample K1	15	3.053	1.1470	50.243	7	7.178	2.637	.015*
Controlled Sample K	15	2.927	.8762	291.193	107	2.721		

Table 3.3.3(a) presents the difference between Elongation of Controlled Sample K and Test Sample K1 at 1>0.015 level of significance. This shows that application of Copper Oxide Nano Particles via In-Situ process significantly increased the Elongation of the Sansevieria Trifasciata Fiber. It can also be seen from Table 3.3.3, that Elongation of the Sample K is 2.93% and after application of Copper Oxide Nano Particles it became 3.05%. This means that the Test Sample K1 can stretch more than the Sample K before breaking.

4. Conclusion

Nano Particles are novel type of resources for improving functional properties of fibers and textiles. Their low cost makes them suitable for industrial applications. In the present study application of nano particles to natural fibers has been performed using Chemical Precipitation Method (In-Situ). This technique is inexpensive and can be used on a commercial scale. FESEM images show application of Copper Oxide Nano Particles on the surface of Sansevieria Trifasciata Fiber but it is not uniformly distributed. XRD Figures show the crystalline nature of the Copper Oxide Nanocoated STF. Breaking Strength and Tenacity of the nanocoated Fiber is seen to decrease due to lack of good bonding of NanoParticles on STF. Elongation of the STF is seen to increase which shows improved stretch ability. So, nanocoated STF can be used in the manufacturing of stretchable yarns and fabrics. Furthermore, different techniques of synthesis of Copper Oxide Nano Particles can be tried and applied on these Fibres to enhance better Mechanical Properties.

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