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

Preeti Alagh* and Dr. Rita Kant**

**PhD Research Scholar, University Institute of Fashion Technology, Panjab University, Chandigarh,*

***Assistant Professor University Institute of Fashion Technology, Panjab University, Chandigarh, India*

Abstract

Sansevieria Trifasciata Fibers were chosen for the study. Copper Oxide Nano Particles were applied on Sansevieria Trifasciata Fiber (STF) through Ex-situ method of Chemical Precipitation Process. X-ray diffraction (XRD) and Field Emission Scanning Electron Microscopy (FESEM) investigated the structure and morphology of the coated and un-coated STFs. These tests were performed in Sophisticated Analytical Instrument Facility,(SAIF) Panjab University, Chandigarh. The results of XRD and FESEM proved that CuO Nano Particles are crystalline in nature and are absorbed onto the surface of STFs respectively.. The mechanical properties includes Breaking Strength, Tenacity and Elongation of uncoated and nanocoated STFs were evaluated. These tests were conducted in Northern India Textile Research Association, Ghaziabad. The Mechanical Properties of the Fiber after the application of Copper Oxide Nano Particles via Ex-situ method enhanced significantly. Breaking Strength, Tenacity and Elongation of the coated STF increased to a great extent which results in more durable and strong Fiber.

Keywords: Sansevieria Trifasciata Fiber, XRD, FESEM

Introduction

Textiles have such a foremost impact on our daily lives that everyone should understand something about the facts of fibres and their attributes. Textiles are used for extensive domain of applications such as covering, warmth, personal adornment and even to display personal wealth. The chief information of textile fibres will ease an intelligent evaluation of fiber brands and types and help in identifying the right quality for the application. [1]

Nano-textiles are most often prepared by adding nanoparticles to the fibre surface during the fibre production itself or its finishing.[2]. Besides this, nano-coatings prepared using natural and synthetic polymers are also being employed in nano-textiles. Now-a-days, the functionalities of textiles are being

improved using a variety of nanoparticles. Various studies are now available which show that the different types of nanoparticles not only improved the existing properties of textiles but also imparted distinct functionalities to the textiles.

Sedighi & Montazer (2016) fabricated cotton fabrics with N-doped copper oxide nanoparticles of different size, shape and morphology. The nano treated cotton fabrics exhibited higher hydrophobicity, tenacity, tensile stress and elongation, besides showing antibacterial properties against S. aureus and E. coli bacteria. [3]. Recently, Hasan (2018) used a wet chemical method to prepare copper oxide nanoparticles which were applied to the 100% cotton woven fabric using the pad dry-cure method. The coated cotton was found to be effective against S. aureus. The antimicrobial activity was observed to sustain 25 wash cycles. [4]. Observing, effect on Copper Oxide Nano Particles on cellulosic fabrics, the present study focuses on the synthesis of Copper Oxide Nano Particles through Ex-situ method of Chemical Precipitation Technique with following Objectives:

1.1 Objectives:-

1.1.1 Application of Copper Oxide Nano Particles on Sansevieria Trifasciata Fibers by Ex-Situ Chemical Precipitation Method.

1.1.2 Characterization of Nano Particles on STF by using FESEM and XRD in SAIF, Panjab University, Chandigarh.

1.1.3 Testing and comparison of results of Mechanical Properties of the STF before and after application of Copper Oxide Nano Particles with Ex-situ Technique.

2. Materials and Methods

2.1 Chemical Precipitation Method (Ex-situ)

In Ex-situ Method, Nano Particles are first prepared and then immobilized on the materials. Copper Oxide Nano Particles were made through the following procedure.

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 min to obtain a clear solution to which 60 M NaOH (0.12 g in 10 mL) solution was added drop by drop. The resultant reaction mixture was then stirred for 1 hour at room temperature to give black precipitates. These black precipitates were finally separated

by centrifugation, washed with ethanol and double distilled water and were further dried at 50˚C to get black powder of Copper Oxide Nanoparticles.

To immobilize Copper Oxide Nanomaterials on fibers, prepared Copper Oxide Nanomaterials (4 gram per litre) was suspended in distilled water and was sonicated in ultrasonic bath under frequency of 35 kHz for 1 hour. The fibre samples were dipped into the prepared suspension, allowed to soaked and dry out at 70^0C for a few hours. The so treated fabrics were washed with distilled water and finally dried at ambient conditions.

2.2 Characterisation of Nanoparticles on Sansevieria Trifasciata Fibers

Morphology and dispersion of synthesized Copper Oxide Nanoparticles on coated fibers were investigated by a Field Emission Scanning Electron Microscopy (Fe-SEM, Plate 2.2a) and X-Ray Diffraction (XRD, Plate 2.2b) in Sophisticated Analytical Instrumentation Facility, Panjab University, Chandigarh.

Plate No. 2.2 a) FESEM Machine

Plate No. 2.2 b) XRD Machine

2.3 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 2.3)

Plate 2.3 Vibrodyne

2.4 Coding of Samples

Sansevieria Trifasciata Fibers were coded as Controlled Sample K and Copper Oxide Nanocoated Sample K2.

2.5 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 ANOVA was applied on the results to draw conclusions.

3. Results and Discussion

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

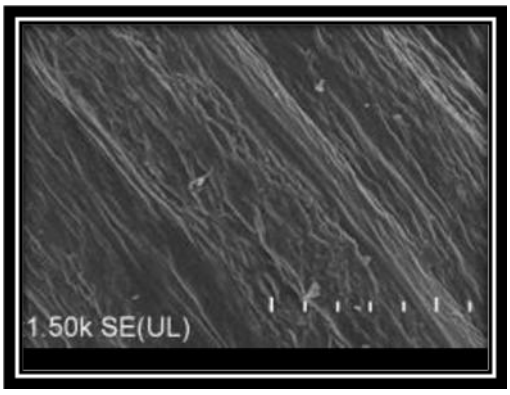


Plate No.3.1 Uncoated STF

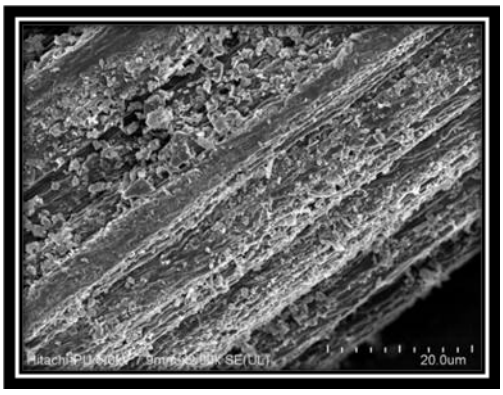
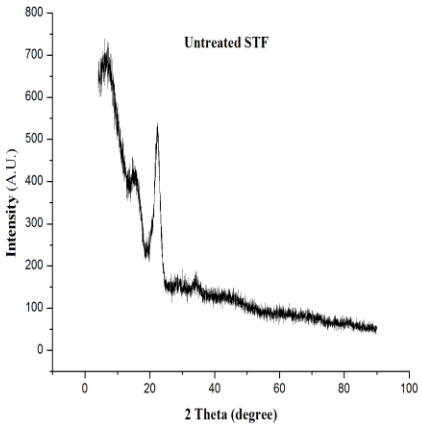


Plate No.3.2 Copper Oxide Nanocoated STF

3.2 X-ray Powder Diffraction of uncoated and Nanocoated fibers



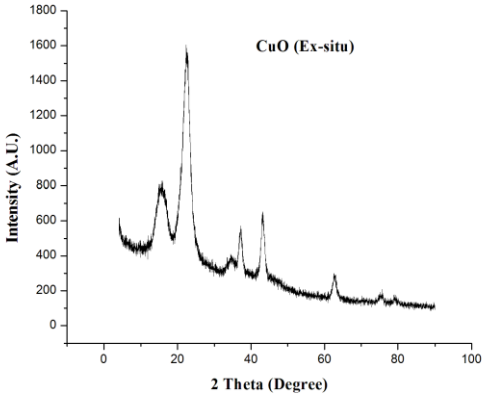


Fig. 3.2 a) XRD Pattern of Uncoated STF **Fig 3.2 b) XRD Pattern of Nanocoated STF**

The diffractogram in figure 3.2(b) shows well defined peaks at around 2Theta=16.46 degree and 22.25 degree for the 110 and 200 characteristic planes of cellulose. The X-ray diffractogram of Copper Oxide Nano Coated Sansevieria Trifasciata Fiber showed distinct peaks at 2 theta values of about 361.12 degree,47.26 degree representing (111) and (112) Bragg reflections of monoclinic structure of Copper Oxide (JCPDS data file 80-1917)

3.3 Mechanical Properties of Sansevieria Trifasciata Fiber before and after application of Copper Oxide (Ex-situ) Nanoparticles

3.3.1 Analysis of Breaking Strength of Sansevieria Trifasciata Fiber before and after application of Copper Oxide (Ex-situ) Nanoparticles

Table 3.3.1: Breaking Strength of Controlled Sample K and Test Sample K2

Test Parameters	Controlled Sample K	Test Sample K2
Breaking Strength (grams)	126.24	291.70

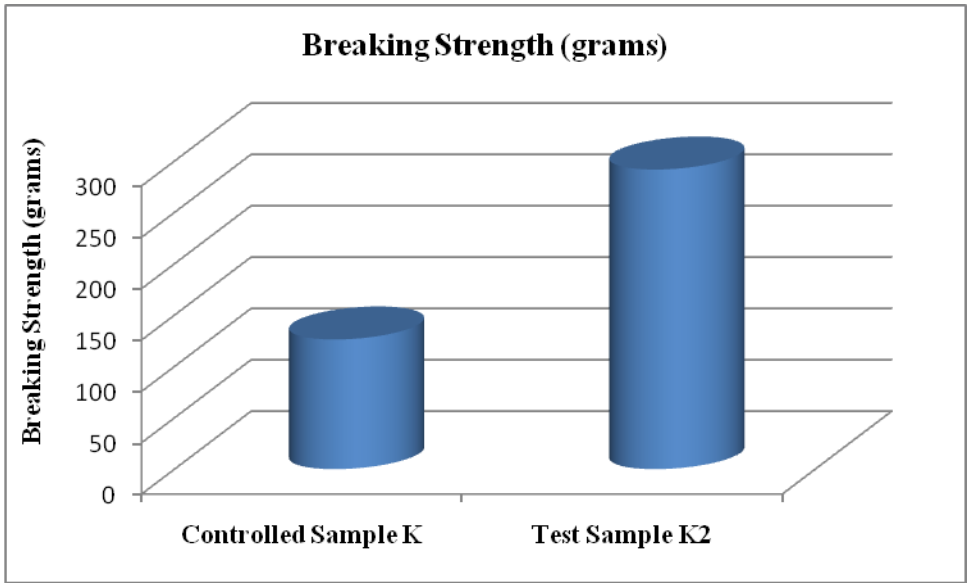


Fig. 3.3.1: Change in Breaking Strength of STF

Application of Anova on observation made with regard to Breaking Strength of STF before and after application of CuO (Ex-situ) shows a significant difference between Breaking Strength of Controlled Sample K and Test Sample K2 at 1<0.001 level of significance. It means with the application of Copper Oxide NanoParticles on Sansevieria Trifasciata Fiber i.e. Test Sample K2 raises the Breaking Strength of the Sansevieria Trifasciata Fiber i.e. Controlled Sample K. Furthermore, it is seen from Table 3.3.1 that the Breaking Strength of the Test Sample K2 exceeds upto 291.70 grams from 126.24 grams (Sample K). [5]. This indicates that Ex-Situ method of application of the Copper Oxide Nano Particles is more suitable than In-Situ where the Breaking Strength decreases substantially.

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

Breaking Strength								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Test Sample K2	15	291.7040	146.32019	455323.668	7	65046.238	6.829	<.001**

Controlled Sample K	15	126.2373	61.84119	1019243.617	107	9525.641		

3.3.2 Analysis of Tenacity of Sansevieria Trifasciata Fiber before and after application of Copper Oxide (Ex-situ) Nanoparticles

Table 3.3.2 Tenacity of Controlled Sample K and Test Sample K2

Test Parameters	**Controlled Sample K**	**Test Sample K2**
Tenacity (gram/denier)	3.40	5.86

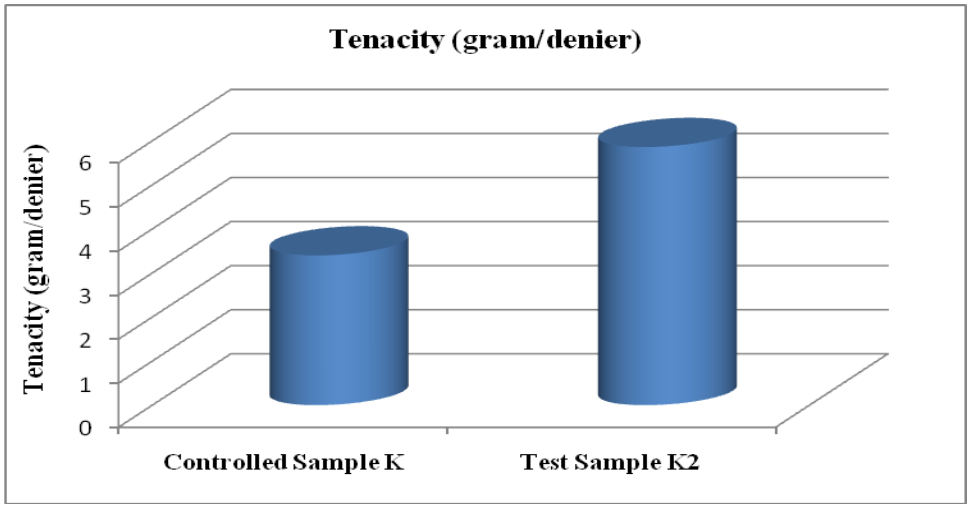


Fig. 3.3.2: Change in Tenacity of STF

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

Tenacity								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Test Sample K2	15	5.8580	2.29149	196.470	7	28.067	8.458	<.001**
Controlled	15	3.3953	1.17685	355.087	107	3.319		

Sample K								

Table 3.3.2(a) shows the difference between Tenacity Test Sample K2 and Controlled Sample K. There is a significant difference in Tenacity at 1>0.001 level of significance. Copper Oxide NanoParticles influenced the Tenacity of the Sansevieria Trifasciata Fiber to a great extent. The Tensile Strength of the Sample K2 shows on increase from 3.40 grams (Sample K) to 5.86 grams per Denier (Test Sample K2) as shown in the Table 3.3.2 (a). The addition of NanoParticles of Copper Oxide into the structure of the fiber caused an improvement in Tensile Strength of the fiber.

3.3.3 Analysis of Elongation of Sansevieria Trifasciata Fiber before and after application of Copper Oxide (Ex-situ) Nanoparticles

Table 3.3.3: Elongation of Controlled Sample K and Test Sample K2

Test Parameters	Controlled Sample K	Test Sample K2
Elongation at break (%)	2.93	4.75

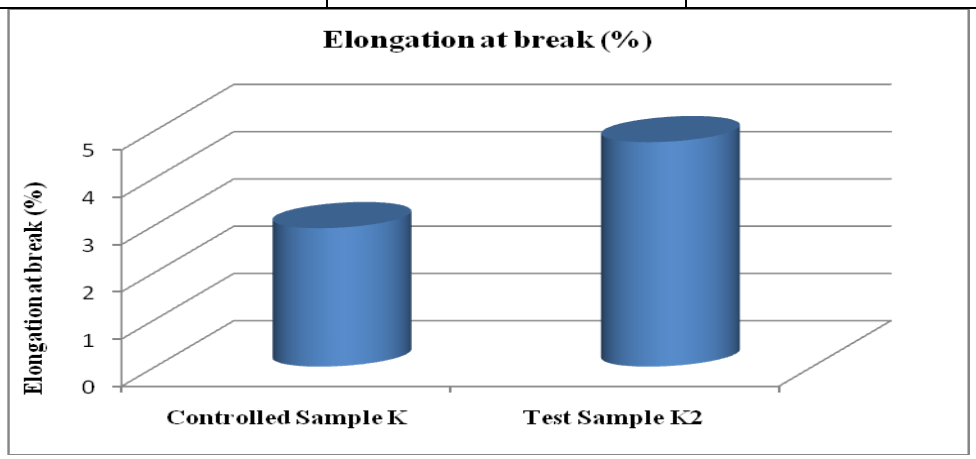


Fig. 3.3.3: Change in Elongation at break of STF

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

Elongation								
Sample	**N**	**Mean**	**Std. Deviation**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**

Test Sample K2	15	4.747	1.2541	50.243	7	7.178	2.637	.015*
Controlled Sample K	15	2.927	.8762	291.193	107	2.721		

On applying Anova test to the observation made with regard to effect of NPs on Elongation of STP, it was seen that there was a significant difference in Elongation of Test Sample K2 as compare to Controlled Sample K at 5% level of significance. The application of Copper Oxide Nano Particles on Sansevieria Trifasciata Fiber led to substantial increase in Elongation. Additionally, the Elongation of Controlled Sample K increased from 2.93 to 4.75 (Test Sample K2) as seen in Tables 3.3.3.[5].The fibers with more Elongation become more elastic fibers and fabrics made up of good elastic recovery maintain their shape.

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