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The Physical Performance and Wearability of the Silk Fabric treated with Silver Nanoparticle Synthesized by the Extract from Cactus

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Abstract. With science and living standards progress, functional textile products become more and more popular. The natural and no added finishing method is especially pursuited by people. In this paper, we report on the use of extract from cactus to synthesize the silver nanoparticles. The particle sizes about 30nm were prepared under the unpolluted environment. The basic raw material is natural selection, preparation method is simple, non-polluting, eco-friendly and to address the reliability of a better way. Natural fabrics treated with natural plant , not only improve the added value of the product ,but also achieve natural of the fabric, meet the requirements of the modern people. This research product the cactus silver nanoparticles silk fabric, demonstrated that the cactus solution can fix the nano-silver uniform on the surface of the silk fabric. Compare with the result of the physical performance and wearability of this fabric, the mechanical properties of the fabric is decline, but the degree of the decline is not high, the moisturizing properties of the finished silk fabric are increased. The result revealed the tensile properties remained basically unchanged, the smoothness, the even and orderly is decline, the roughness of the surface is increased, the softness is weakened, the bulkiness is reduce, the fullness is weakened, the wrinkle recovery capabilities is improved.

Introduction

The silk products has the reputation of “Fiber Queen” from ancient times, but because of the composition of the proteins and the water, the microorganism is easy to breed in the silk surface. This breed is not only because the function degenerated, but also leads to great damage to human health. In order to realize the antibacterial function of the silk, the antibacterial effect of the nano-silver is paid people’s more attention, and the potential applications are attract many researchers to notice it.

There are many ways to making nano-silver, the method of use plant extracts to prepared silver nanoparticles is relatively simple. This way is suitable for large-scale preparation of nanoparticles. People have been found many plants can be used to making nano-silver, such as camphor leaves[1], geranium[2], ginkgo leaves and magnolia[3],etc. Cactus contains large amounts of plant polysaccharides[4], flavonoides, many kinds of vitamins, amino acids and other ingredients [5]. The cactus polysaccharide contains rich reduction groups, it can deoxygenate the metal ions to the metal simple substance[6]. The research applies cactus as the raw material, studying the possibility of using the cactus to synthesis nano-silver and the wearability of the finished fabric.

Experimental

Preparation and characterization of cactus nano silver solution. Some cactus powder was taken to immerse in deionized water, vacuum leaching, and obtained filtrate as reserve. This solution was used to deoxygenize silver ammonia and obtain the nano-silver solution. (Specific preparation and characterization please refer to Textile Technology, 2010, 18(3).

Preparation of cactus nano-particles and their application onto B.mori silk for antibacterial treatment). The silk fabric was put into the solution, liquor ratio is 1:50, airing under natural conditions after washing. The performance of the finished silk fabric was tested.

Results and Discussion

SEM of the silk fabric before and after finishing. Fig.1 is the SEM of the silk fabric before and after finishing. This figure show that compared with ordinary silk fibers, the nano-silver particles were uniformly distributed on the surface of fibers that were treated by nano-silver colloid solution, this proved nano-silver particles were adsorbed and fixed on the surface of silk fabric.

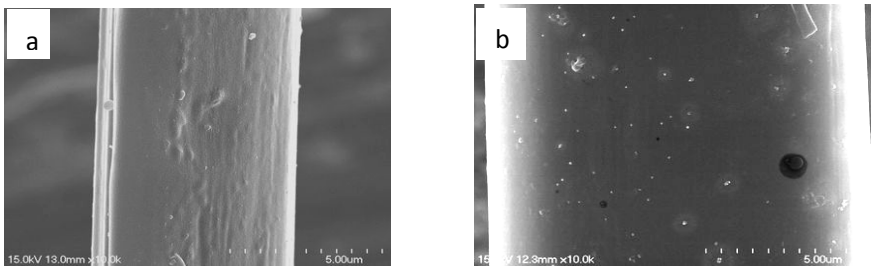

Fig. 1 SEM images of surface of (a)original silk fibers and (b)nano-silver treated silk fibers

Wearability of modified silk finished by cactus nano-silver solution. Silk fabric finished by impregnation method, liquor ratio is 1:50. Test the wearability of the silk fabrics after treated.

Mechanical Properties of silk fabric. We can see from Table 1 and Table 2 that with the temperature and the time increased, the breaking strength of the fabric is fall in a certain degree. This is because the PH of the solution used to finishing silk fabric is alkaline. The silk is a fabric that it is acid-proof and not alkali[7], so the alkaline of the solution is destroyed the strength of the fabric a little. Consider this characteristic, the time and the temperature should not be too long and too big. We choose the temperature is 60℃, the time is 60min.

Table 1 Temperature Infect of Fabric Breaking Strength (N)

N	Original	1#	2#	3#	4#	5#
Warp	554.50	534.32	522.17	511.54	490.10	470.26
Weft	600.23	570.11	554.39	515.73	501.18	480.67

Note:1#—Homoeothermy, 2#—40℃, 3#—60℃, 4#—80℃, 5#—100℃.

Table 2 Time infect of Fabric Breaking Strength (N)

N	Original	6#	7#	8#	9#	10#
Warp	554.50	542.11	533.19	525.23	503.37	489.37
Weft	600.23	584.37	575.59	550.38	526.49	504.65

Note:6#—20min, 7#—40min, 8#—60min, 9#—80min, 10#—100min.

Moisturizing properties of the fabric. From Table 3 we can see, the moisturizing properties of the fabric can research 160%, the moisturizing properties is improved. This is because the cactus contain cactus polysaccharide, this polysaccharide have moisturizing properties. The cactus also contain some amino acids and metal salts, this is the same of the composition of natural moisturizing factor, so it also can maintain the humidity. The cactus provide a natural moisturizing system for the skin, the finished fabric has the excellent moisturizing properties.

Table 3 Moisturizing properties of the fabric

Moisturizing properties (%)	2h	5h
Original	100	100
Finished fabric	160	164

Water absorption of the fabric. From Table 4 we can see the water absorption of the fabric finished by the cactus nano-silver particles is drop, this is because during the finishing process, the alkaline solution is damaged the hydroxyl and carboxyl of the silk, reduced the water absorption capacity of the fabric, but this reduction is not serious.

Table 4 Absorption Parameters of the Fabric (mm)

	Original	Processing samples
Warp	139	130
Weft	132	129

Fabric Style. This experiments have done the fabric tensile test, compression test and shear test, measured the tensile linearity, tensile energy, tensile resilience, compression linearity, compression function, compression elasticity, lagging power, etc.

Tensile properties and Surface properties. From Table 5 we can see the tensile linearity and the tensile resilience of the fabric is basically unchanged after finishing. In a word, the tensile properties of the fabric remained basically unchanged, the even and orderly of the fabric is decline, the roughness of the surface is increased.

Compression performance

From Table 6 we can see the compression linearity of the fabric after finishing is decline, the softness of the fabric is weakened; the compression function is reduce, the bulkiness of the fabric is reduce; the compression elasticity is reduce, the fullness is weakened.

Table 5 Stretching parameters and Surface Properties of the silk fabric

Characterize		Original	Processing samples
Tensile Linearity (-)	Warp	0.60	0.50
	Weft	0.53	0.55
Tensile Energy (N·cm/cm^2)	Warp	4.55	8.25
	Weft	9.50	4.10
Tensile Resilience (%)	Warp	85.62	63.01
	Weft	72.34	78.71
Average Friction Coefficient (-)	Warp	0.27	0.14
	Weft	0.23	0.18
Friction Coefficient Average Variance (-)	Warp	0.03	0.01
	Weft	0.04	0.01
Surface Roughness (u)	Warp	2.42	1.90
	Weft	3.25	1.76

Table 6 Compression Performance of the silk fabric

Characterize	Original	Processing samples
Compression Linearity (-)	0.28	0.14
Compression Function (N·cm/cm^2)	0.05	0.07
Compression Elasticity (%)	134.25	83.45

Shear Properties. Table 7 tell us the lagging power of the fabric after finishing is reduce, this illustrate the wrinkle recovery capabilities of the fabric is improved.

Table 7 Shear Properties of the silk fabric

Characterize		Original	Processing samples
Shear Stiffness (N/cm deg)	Warp	0.24	0.20
	Weft	0.24	0.24
Lagging Power (2HG) (N/cm)	Warp	0.06	0.05
	Weft	0.07	0.02
Lagging Power (2HG5) (N/cm)	Warp	0.17	0.09
	Weft	0.18	0.07

Summary

In this study, the silk fabric was treated with silver nanoparticle synthesized by the extract from cactus. This testing demonstrated that the cactus solution can fix the nano-silver uniform on the surface of the silk fabric. The mechanical properties of the fabric are decline, but the degree of the decline is not high. The moisturizing properties of the finished silk fabric are increased, but the water absorption is decreased. The tensile properties of the fabric remained basically unchanged, the smoothness and the even and orderly of the fabric is decline, the roughness of the surface is

increased, the softness of the fabric is weakened, the bulkiness of the fabric is reduce, the fullness is weakened, the wrinkle recovery capabilities of the fabric is improved.

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