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Exploration on the Production of Natural Green Anti-bacterial Health-care Textiles

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Abstract. Chitosan has the function of anti-bacterial, and it can produce natural green anti-bacterial health-care textiles. However, after the finishing process, the fabrics properties are influenced as well. With the experiments, we study the impaction of chitosan on the fabrics properties. The results indicate: the anti-bacterial performance is good after the finishing process, and the shrinkage has been greatly improved.

Introduction

The textiles provide a good medium for the microbial adhesion and spread, as a result, with the development of science technology and improvement of living standard, the textiles require for more and higher demands on the antibacterial antifungal treatment world-widely. Since we have entered the WTO, to make our country transform from big textiles country to strong textiles country, upgrade the additional textiles value is one of the very important means. Therefore, our country should follow the development trend of world textiles, and participate in the international market competition with products that yields high added value and produced with advanced technology.

Chitosan is a natural polycation polysaccharide, and the product of chitin deacetylation. Chitin consists in shell of crustaceans, insects and other invertebrates, cell wall of algae and fungi. The structure of chitosan is similar to cellulose, and hydroxy is substituted by a more lively Amino. Chitin is rich in resources, which is the second largest biological resources only after cellulose on the earth. The bio-synthesis is amount to 10 billion tons per year, which appears to be inexhaustible [1,2].Meanwhile, since it is natural, and has good biocompatibility, application study is active world-widely. The application field has been penetrated into industry, agriculture, environmental protection, national defense, and other aspects of living. In the textile field, people pay more attention to the chitosan application, and make researches on its excellent performance. As a member of Chitin Application Team, we utilize its excellent antibacterial property, and explore on the natural anti-bacterial health-care textiles. After a series of tests, we successfully developed the industrialized pilot testing products. This article mainly discuss about this.

The Antibacterial Mechanism of Chitosan

Basically, the chitosan has two antibacterial mechanisms: The mutual attraction between amino cation of chitosan and anions of sialic acid phospholipid in microorganism cell wall constraints the microbial freedom, impedes the metabolism and reproduction[3];The chitosan molecules of quite low molecular weight invade the microbial cells, and impede the genetic code of microbes replication from DNA to RNA, thus impede the propagation of microorganisms [4].

The development of the anti-bacterial health-care textiles is mainly proceed from the textile finishing application of chitosan. In the small scale experiments, on the premise of maintaining the antimicrobial properties of textile fabrics, we successfully solve the technical problems such as the stiff feeling and yellow discolouration after chitosan dispose, and make some progress in textiles wrinkle-free, shrink-proof performance. And we finally successfully develop the pilot testing products.

Test Portion

Raw material. Chitosan, acetic acid for industrial use, medical gauze, raschel blanket, knitted fabrics and gripper jacquard and so on.

Solution preparation. Chitosan powder down → water → acetate → stirring →quiescence defoaming

Treatment craft. Conditioning fluid padding infiltration →$NaHCO_3$ treatment →washing →softing→drying → finishing

Craft prescription. Acetic acid: 1%; Chitosan: a variety of concentrations

Test results. To enable the textile finished by chitosan has the antibacterial effect, without affecting its original physical properties, we conducted a number of comparison tests with various chitosan concentrations. The representative 14.6tex × 27.8tex 551 × 295 cotton waffle shrinkage test is shown in Table 1 and Figure 1. JC 27.8 tex×2 250g·m^{-2} knitted fabrics shrinkage test is shown in Table 2 and Figure 2. And 9.7tex × 14.6tex 677 × 465 cotton jacquard WRA test is shown in Table 3 and Figure 3.

Table 1 The Shrinkage of Cotton Waffle Comparison Test

Washing times	Shrinkage of different concentrations of chitosan（%）				
	0.0%(Original Sample)	0.1%	0.3%	0.5%	1.0%
1	-2.9%	-2.0%	-1.7%	-1.2%	-1.4%
2	-3.4%	-2.7%	-2.1%	-1.8%	-1.5%
3	-4.0%	-2.9%	-2.6%	-2.0%	-1.9%

(①equipment in use: YG701N automatic shrinkage testing machine; ② Test Standard: GB / T 8629-2001 Textiles Trial domestic washing and drying process)

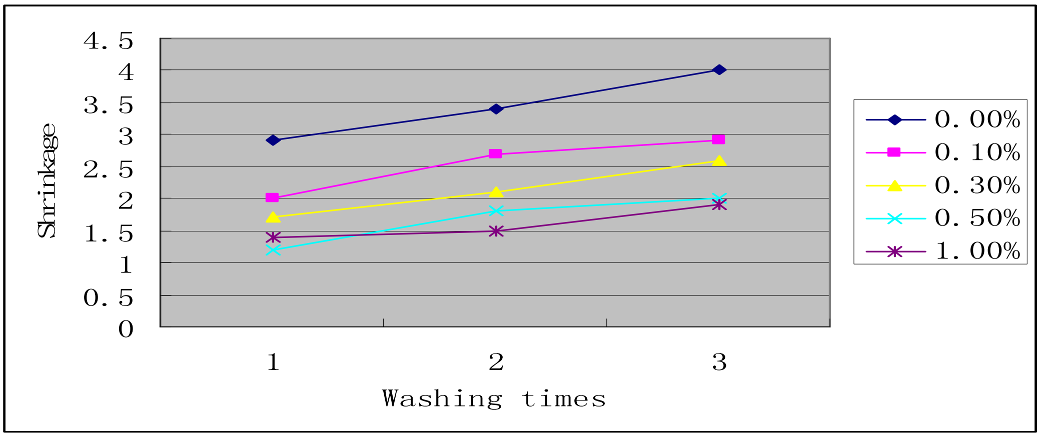

Fig.1 The Shrinkage of Cotton Waffle

Table 2 The Shrinkage of Cotton Combing Knitted Fabric Comparison Test

Washing times	Shrinkage of different concentrations of chitosan（%）				
	0.0%(Original Sample)	0.1%	0.3%	0.5%	1.0%
1	-4.6%	-3.5%	-2.9%	-2.5%	-2.4%
2	-5.1%	-4.1%	-3.2%	-2.7%	-2.5%
3	-5.5%	-4.4%	-3.5%	-3.0%	-2.8%

(①equipment in use: YG701N automatic shrinkage testing machine; ② Test Standard: GB / T 8629-2001 Textiles Trial domestic washing and drying process)

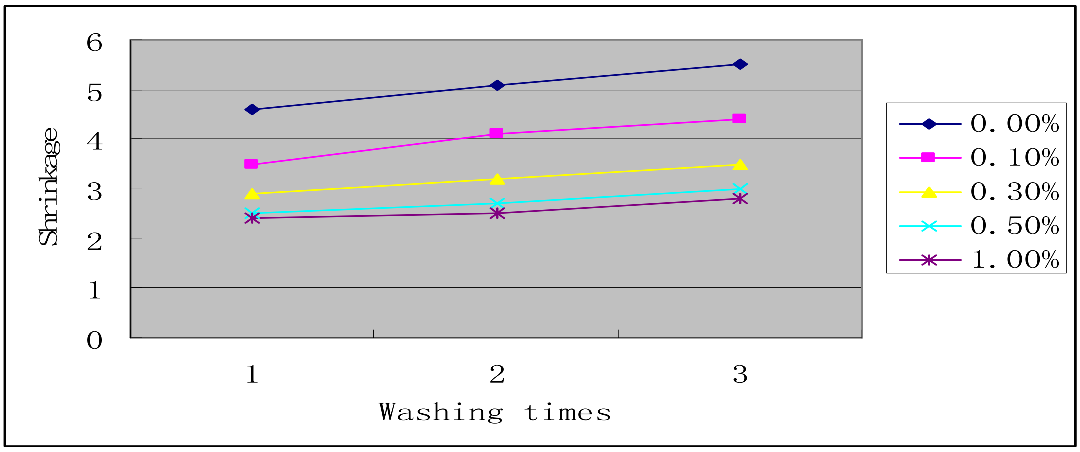

Fig.2 The Shrinkage of Cotton Combing Knitted Fabric

Table 3 Cotton Jacquard WRA Comparison Test

Recovery angle	chitosan concentration（%）				
	0.0%(Original Sample)	0.1%	0.3%	0.5%	1.0%
warp (°)	58.2	58.3	59.6	58.7	51.3
weft (°)	64.7	67.1	68.3	61.5	58.9
warp+weft(°)	122.9	125.4	127.9	120.2	110.2

(①equipment in use: M003A wrinkle recovery angle tester; ② test standard: GB/T3819-1997 textile fabrics Determination of fabric crease resilience recovery angle method)

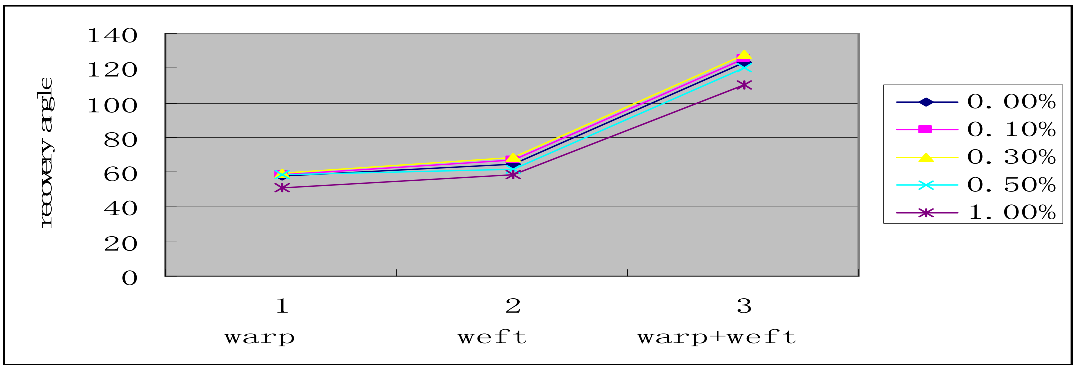

Fig.3 The Recovery Angle of Cotton Jacquard WRA

The overall results show that the anti-shrinkage increase by 25% on average, rebound resilience recovery rate is about 60-70%. The flexibility is increased, and other physical parameters are similar to the ordinary textiles, while with the increase of chitosan concentration, there is a trend that hand feeling become worse. When the concentration is more than 0.3%, the fabric elasticity will cause adverse effects.

Antibacterial properties. We test the chitosan treated fabric with SBZ 1036-96 non-leaching antibacterial hygienic products effect test method. The results show that when the chitosan concentration is above 0.3%, it has excellent antibiotic property of Escherichia coli and Staphylococcus aureus; the antibiotic property is still good after soap 50 times. The comparison between antimicrobial agents treated textiles and chitosan treated textiles is shown in Table 4.

Table 4 The Comparison Between Two Textiles with Different Treatment

Comparison Items	Chitin /Chitosan Textiles	Textiles Treated with Antibacterial Agents
Antibacterial Effect	good	good
Antibacterial Perdurability	long	ordinary
Antibacterial Effect washability	washable	not washable
Impact on human body	no sensitization	side effects
Impact on Physical properties	improve the elasticity and shrink resistant property	none

Taking all factors into account, 0.3% -0.5% chitosan concentration is more appropriate.

Conclusions

From the test, the fabric treated with chitosan, after washing 50 times, the cross-link between the chitosan and the fabric is relatively stable and solid.

After treated with chitosan, the fabric shrinkage improved significantly, which provided conditions for the chitosan to substitute resin finishing.

This project has simple craft, high function and added value, meanwhile, it is easy to operate. According to the preliminary estimate, textiles treated with chitosan, the additional cost increased by 3%, while the price increased by more than 10%, the economic benefits is remarkable. At the present time, the chitin raw material is expensive, this craft is of great practical significance and promotional value.

Chitosan has broad-spectrum antibacterial effect, and it can inhibit various bacteria and fungi.

The craft technology of chitosan development in the textile industry is feasible and correspondence with the contemporary health care and environmental protection trend, it can also increase the technical contents of textiles, and improve the textile products quality.

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