Enzymatic Preparation of Silk/Cellulose Blend Fabrics

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1. Introduction

Silk fiber is one of the most important textile materials and has been used as a textile fiber for over 5000 years[1]. The silkworm cocoon silk fiber is composed of sericin(22~25%), fibroin(62.5~67%), water and mineral salts[2]. Since sericin gives a harsh and stiff feeling to the fiber, it should be removed to have lustrous and soft handle white silk.

Degumming, the process for removal of sericin, is therefore an essential process to obtain an ideal fiber for the textile industry. Conventional processes for degumming are extraction with hot water, boiling off in soap, alkaline solution or acid solution. Recently enzymatic degumming processes have been drawn an attention not only because the process is environmentally friendly process but also the degumming process affects the quality and mechanical properties of silk fiber[3, 4].

While the silk fiber is used alone as a textile material, it is also blend with other textile materials to obtain better properties and lowered cost. Cellulosic materials are preferred to blend with other materials because of their low cost and excellent chemical and mechanical properties[5]. In the case of blend fabrics, pretreatment processes such as desizing, scouring, bleaching, should be carried carefully since the process for each one of the material is different and could deteriorate the properties of another material among the blend fabrics. Several degumming processes were carried out in this work to investigate the effect of each process on the properties of blend fabrics and suitability for use of the blend fabrics as women dress.

2. Materials and methods

Silk/cellulose blend fabric

The Treatments were carried out on a silk/modal (55%of Silk and 45% modal) blend fabric. The weight of fabric was 100g/yd. Impurities such as sizing materials on the fabric were analyzed before the treatment in order to seek the possibility that all the impurities including sericin are removed with a single treatment.

Enzymes and other chemicals

The commercial proteases, Savinase and Alcalase, used for enzymatic degumming of the silk were kindly provided from Novozymes Korea. Alkali and other auxiliaries were purchased from Sigma-Adrich and used as they were received.

Fabric treatment

The blend fabric was treated either with enzyme solution, hot water, or alkaline solutions. Various experimental conditions were used for both alkaline and enzyme treatment in order to establish an optimum condition. All experiments were carried out in an IR Dyeing machine.

Testing

Water absorbency of treated fabrics was measured using Gravimetric Absorbency Testing System (GATS). The degree of sericin removal was examined by dying with Direct Red80. As another tool for evaluating degumming efficiency, the weight loss was measured as well. Tensile strength was measured before and after the treatment. The Kawabata Evaluation System for Fabrics(KES-F) was employed to evaluate the handle properties of treated fabrics.

3. Results and Discussion

Although the weight loss of alkali treated fabrics much higher than enzyme treated fabrics, the water absorbency of treated fabrics was a little bit higher for enzyme treated fabrics compared to alkali treated fabrics(Figs 2~3). However, the difference was not significant.

The content of sericin in the sample fabrics assumed to be around 12~14wt% since the weight portion of silk is 55% in the fabric. Considering the fact, more than 14% of weight loss may have come from either fibroin or modal. The data from tensile strength measurement could be answer to the question where the high amount of weight loss came from after the alkali treatment. The fabric treated even with 0.1g/L of alkali lost 45% of tensile strength although the weight loss was less than 5% (Fig.3). In contrast to that, the fabric treated with enzymes showed similar tensile strength even after 12%of the weight reduction.

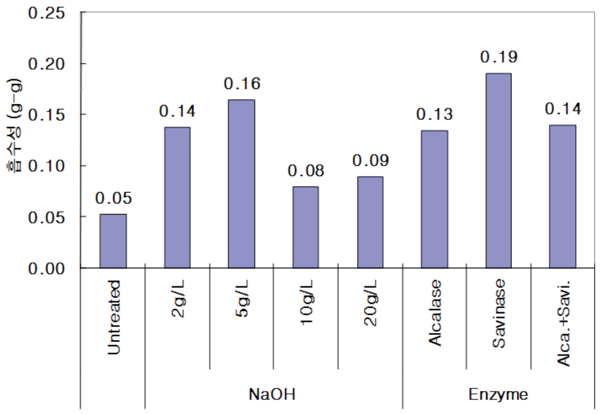

Fig. 1. Water absorbency of specimens.

Silk fibroin is a semicrystalline polymer whereas sericin is amorphous [6]. Fibroin chains are aligned along the fiber axis held together by a close network of interchain hydrogen bonds, therefore, strength loss by degumming implied that the degradation of fibroin. The results showed that the degradation of fibroin might be started before the completion of sericin removal even with the low concentration such as 0.1 g/L of alkali treatment.

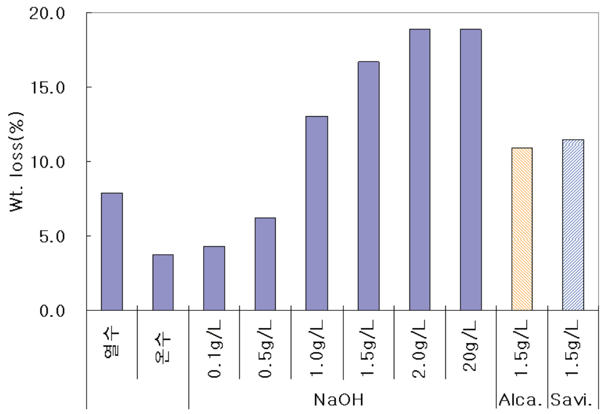

Fig. 2. Weight loss of treated fabric.

The direct Red 80 was used to evaluate the content of sericin in the silk because the dye is only dyed onto sericin. According to the staining evaluation, the content of sericin was reduced dramatically by alkali treatment (Fig.4). The results showed that the sericin content of treated fabric with 0.1g/L of alkali was similar with fabrics treated with 1.5g/L enzyme solution.

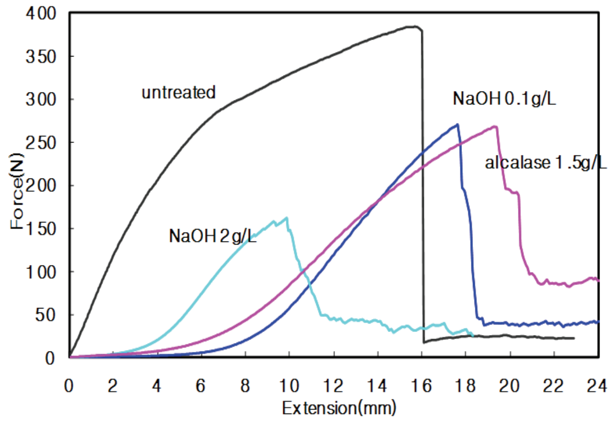

Fig. 3. Tensile strength of treated fabrics.

Considering the weight loss and tensile strength, the content of sericine in enzyme treated fabric was much higher compared to the alkali treated fabrics. The phenomenon can be explained by working mechanism of alkali and enzyme. Alkali attacks the substrate cross-sectionally but enzyme is working only the surface the material.

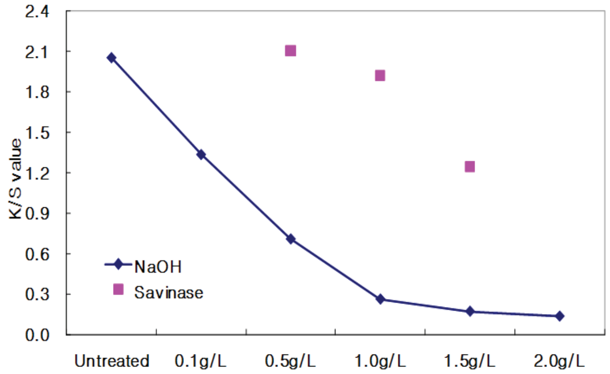

Fig. 4. K/S value of stained fabrics after degummed

4. Reference

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