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Characterization of sericin obtained from cocoons and silk yarns

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Abstract

During silk transformation process one of the byproducts obtained is silk sericin (SS). Although sericin is currently treated as a waste in Colombia, in recent years it has been attributed with important biological properties, such as corrosion resistance, antimicrobial activity, ultraviolet radiation (UV) protection, easy absorption and release of moisture, among others. Therefore, many researchers are looking for alternative uses to develop value-added products in the biomedical, pharmaceutical, cosmetic, and food industries. This work has as a goal to create knowledge about properties of the sericin produced in Colombia by characterizing extracted silk sericin (SS) from cocoons (SSC) and yarns (SSY) as raw materials. Sericin was extracted by using water under pressure in an autoclave (121 °C for 30 min, and a liquor ratio 1:30 (w/v)), and dehydrated by freeze-drying. Sericin samples extracted and dehydrated were characterized by Scanning Electron Microscopy (SEM), Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) and Thermogravimetric Analysis (TGA). From the results it has been concluded that textile silk process can affect the properties of sericin samples, and therefore, the raw material chosen for the extraction (cocoons or yarns) plays an important role on the characteristics of extracted samples.

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Keywords: Silk cocoons; silk yarns, secondary structure, thermal stability.

1. Introduction

Today, there is a large increase in looking for alternatives to take advantage of by-products from silk fiber production. One example is sericin, a protein extracted during degumming process of silk fiber. Due to sericin properties, such as corrosion resistance, antimicrobial activity, protection of solar ultraviolet radiation (UV), easy

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absorption and release of moisture, among others [1], there are many research works looking for new applications of this protein. Nowadays, Asian countries use sericin to develop different products, however, in Colombia it is discarded since its commercial potential is unknown. Considering that sericin has become a viable source to develop different natural products, there is a great opportunity to improve the knowledge about how sericin is obtained; since quality and properties determine its application in food, cosmetic and medical industries [2].

During silk textile process, sericin should be removed; the goal of this procedure is to obtain silk fibers with shiny aspect, soft handle, and elegant drape [3]. There are different extraction methods to remove sericin from silk, like a) hot aqueous solution of sodium carbonate [4], b) aqueous solution of urea at 85 °C [5], c) autoclaving [6], among others; all of them are based on protein solubility in water. Extraction methods have a high influence on the extraction yield of the raw material, and they have an important effect on the sericin characteristics [7]. One of the most common extraction methods is the autoclaving process due to no chemicals are required, and dialysis process is not necessary [8].

In Colombia the silk transformation processes are carried out by small-scale producers, which are grouped by la Corporación para el Desarrollo de la Sericultura del Cauca CORSEDA (Popayán-Colombia). These producers are working to improve the process productivity; therefore they are looking for an alternative use of byproducts as sericin. Since 2012, the Universidad Pontificia Bolivariana (UPB) has been working to reach the CORSEDA′ objective. Considering the advantages of autoclaving process, the properties of sericin extracted by this method has been studied. The idea is that CORSEDA can transform the process which today they are using. This process is carried out with aqueous solution containing coconut soap and sodium bicarbonate. This change could decrease the chemicals consumption and easily recover the sericin. The UPB is working to take advantage not only yarns but also defective cocoons. This last one is today used to produce handicrafts, which are products with low value in Colombia.

This work looks to evaluate the characteristics of sericin extracted from defective cocoons (SSC) and silk yarns (SSY), which were supplied by CORSEDA. The degumming process was carried out using an autoclaving due to the reasons explained earlier. Obtained samples were dehydrated by freeze-drying to preserve the sericin properties. Dried sericin was characterized by infrared Fourier transform spectroscopy (FTIR), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). A quantitative analysis on the structural characteristics of sericin was carried out at the amide I band between 1600-1700 cm^{-1} through the peak-fitting method, using the FTIR analysis.

2. Methodology

Silk yarn (SSY) and defective cocoons (SSC) were provided by "Corporación para el Desarrollo de la Sericultura del Cauca" CORSEDA. Before extraction, cocoons previously cleaned were cut in small pieces, and yarns were wound forming skeins. Samples were dried in a forced air oven at 105 °C for 24 h and left in a desiccator for 1 h. Sericin extraction was carried out using distilled water and an autoclave at 121 °C for 30 min, and a liquor ratio 1:30 (w/v). Cocoons and yarn were treated separately. The solution recovered after each treatment was filtered. After that, the sericin solution obtained was frozen in liquid nitrogen (196 °C) and then lyophilized in a laboratory scale freeze dryer.

The surface morphology of sericin samples was observed by Scanning Electron Microscopy (SEM). The analyses were performed using a JEOL JSM-6490LV with gold covering (DENTON VACUUM Desk IV) in order to improve the resolution of the images. The structure of SSY and SSC were analyzed by Fourier Transform Infrared-Attenuated Total Reflection Spectroscopy (FTIR-ATR) using an IR Affinity 1S spectrophotometer (Shimadzu), equipped with an ATR (SPECAC). 64 scans with a resolution of 4 cm^{-1} were coded in the range of 400 to 4000 cm^{-1} for each measurement. The relative content of the secondary structures was studied through the peak-fitting method. The analysis was carried out at the Amide I band, between 1600-1700 cm^{-1} [9]. Thermogravimetric analysis (TGA)