CHITOSAN-BASED ANTIMICROBIAL LEATHER COATINGS: EVALUATION OF THE PILOT SCALE PRODUCTION

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Introduction

Chitosan is a biopolymer that is being increasingly used in distinct areas such as pharmaceutical, biomedical, cosmetics, food industry and agriculture. Among the interesting biological activities that have been ascribed to chitosan, the antimicrobial activity is probably the one that generates the higher number of applications. Considering that feet present favorable conditions for microorganism’s growth due to the high relative humidity conditions, warmth and nutrients availability (from feet sweat), one of such applications can be the use of chitosan to provide an antimicrobial coating for leather footwear components [1]. Previous studies, in which leather impregnation with chitosan was performed at laboratory scale, showed that samples presented antimicrobial activity against Gram-positive and Gram-negative bacteria [1]. In this work, the antimicrobial activity of chitosan-based leather coatings, produced at a pilot scale, was evaluated.

Material and methods

Samples: Leather samples arising from the industrial dye fixation stage were coated with chitosan using a pilot scale drum (pot used at industrial scale in leather production process). In this work the process variables studied were: (i) amount of applied chitosan (three chitosan/leather weight ratios were evaluated, namely 0.5%, 1% and 3%); (ii) type of acid used to prepare chitosan solution (two acids, formic and acetic, were tested. Formic acid was chosen because it is already used in the industrial leather tanning process on dye fixation stage, and acetic acid because it is the most referred in the literature for chitosan solubilization); and (iii) washing effect (leather samples coated with chitosan were divided in two parts and only one was washed after the coating process).

For all experiments, half a hide split in two parts was impregnated in the pilot scale drum during 1 hour at 50ºC. After the coating process, the leather was dried in industrial conditions and stored in closed plastic bags before testing.

Antimicrobial activity: The antimicrobial activity was evaluated following two different tests, namely Test 1: Agar Diffusion Method based on the AATCC 147 test method [2], and Test 2: Standard Test Method under Dynamic Contact Conditions, according to the general guides of ASTM Standard E 2149-01 [3]. In Test 2, colony counts were performed by the agar incorporation method and results expressed in colony forming units per mL (CFU/mL). Both tests were performed using Escherichia coli ATCC 10536.

Results and discussion

In this study, leather impregnation with chitosan was performed during dye fixation stage, one of the finishing steps of the industrial leather production process. Among the advantages, this stage already comprises the use of acidic solutions, which simplifies the introduction of this new stage in the whole process. Regarding the antimicrobial activity, Test 1 was performed as a screening test for all samples. Results showed that the major differences between the coated samples are related with the used chitosan mass for impregnation. The sample coated with 0.5% chitosan presented the lowest antimicrobial activity, while samples coated with 1% and 3% have shown superior inhibition areas, but similar between each other. Moreover, results also showed that there are no significant differences associated with the used acid or resulting from using the washing step. Figure 1 presents an example of the antimicrobial activity of two samples coated with 1 and 3% chitosan in formic acid.