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Biodeterioration of Vegetable-tanned Leather

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Abstract

Fugal might thrive on tanned leathers, resulting in undesirable and irreversible changes in them, which does harm to the leather items. In the present work, the leather tanned with tannic acid (TA) was exposed to *penicillium* and *aspergillus niger* for up to 90 days to study the biodeterioration mechanism. The deterioration of structure, thermal stability, tensile properties and morphology of the leathers caused by microbiological attack were identified by Attenuated Total Reflectance-Fourier infrared transform (ATR-FTIR), Texture Analyzer and Scanning Electron Microscope (SEM). Both of *penicillium* and *aspergillus niger* could cause the deterioration of grain layer and tensile strength of samples. Compared with after being treated with *aspergillus niger*, the tensile strength of one after being treated with penicillium for over 60 days is greatly reduced. Based on ATR-FTIR results, the relative intensity of bands at 1710 cm^{-1} and 1611 cm^{-1} relating to the vibration of C=O and C=C respectively from TA decreased, which suggested the destroyment of the structure of tanning agent in the samples. Moreover, both the red shift of the amide I band and blue shift of amide II band indicated that the collagen structure was broken due to the growth of *penicillium* and *aspergillus niger*.

Introduction

The use of leather products can be traced back to ancient times. Thus, archeological excavations often recover a large number of leather artifacts including shoes and boots, and clothes, etc. Excavated leather is susceptible to microbial growth as evidenced by white-gray and colored deposits that often cover the whole surface of objects like dust. This because the collagen and lipids in leather provides a suitable substrate for many microorganisms. So, biodegradation is a crucial factor to impair the leather properties. Generally, biodeterioration takes place under high relative humidity that enable bacteria, actinomycetes or fungi to grow, which results in the aesthetical changes and weaken the leather structure until complete destruction occurs. The prevention of microbial growth in museums as well as the development of appropriate treatment measures for contaminated leather objects is a challenge for restorers and museum curators.

Methods

The leather tanned with TA was sterilized with 3% H_2O_2 for 1 h, incubated with pure *penicillium* and *aspergillus niger* respectively and cultivated on agar Czapek medium without carbon and nitrogen sources for 15–90 days. The cultivated temperature was controlled at 25±2℃ and the relative humidity is maintained at 99.9% by saturated potassium sulfate solution in an enclosed chamber. After 15, 30, 60 and 90 days, the samples were washed to remove the mould and dried in the air.

Results and discussion

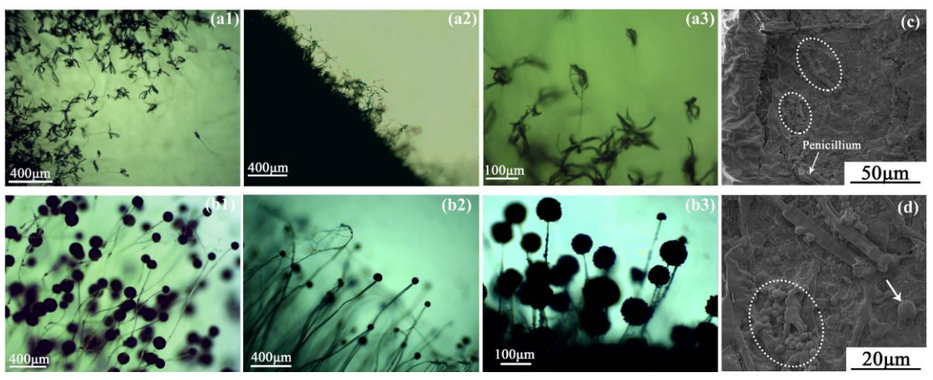

Figure 1 The morphology of strains on the surface of TA tanned leathers: (a1–a3) M1 strain, (b1–b3) M2 strain and (c–d) SEM images.

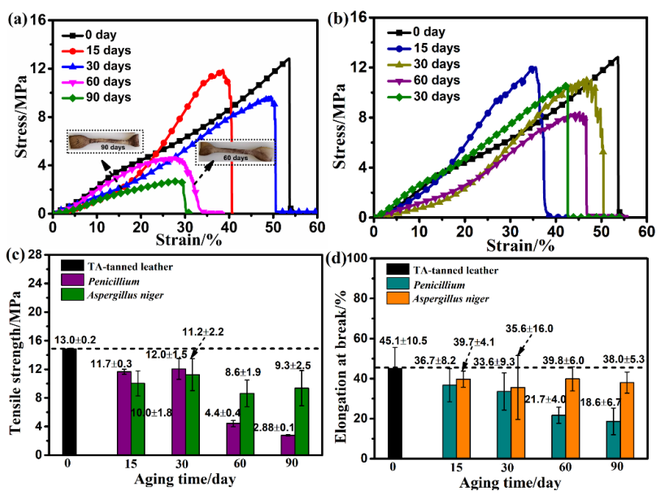

Figure 2 (a) (b) Stress–strain curves, (c) tensile strength and (d) elongation at break of TA-tanned leather after aging with *penicillium* and *aspergillus niger* for 0, 15, 30, 60 and 90 days.

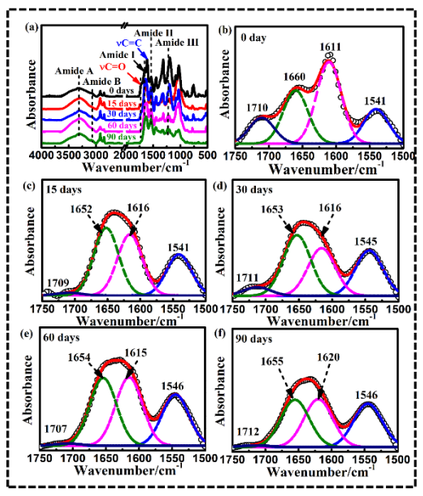

Figure 3 (a) ATR−FTIR spectra and peak separation spectra of amide I band and amide II band of TA-tanned leather after aging with *penicillium* for (b) 0 day, (c) 15 days, (d) 30 days, (e) 60 days and (f) 90 days.

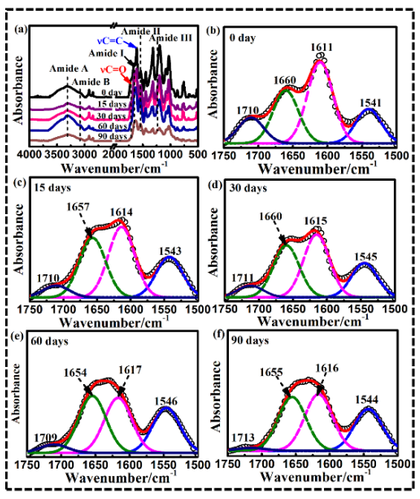

Figure 4 (a) ATR−FTIR spectra and peak separation spectra of amide I band and amide II band of TA-tanned leather after aging with *penicillium* for (b) 0 day, (c) 15 days, (d) 30 days, (e) 60 days and (f) 90 days.

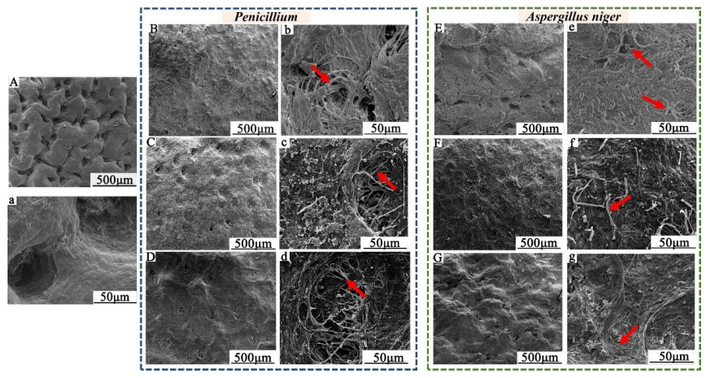

Figure 5 SEM images of grain layer of TA-tanned leather after aging with *penicillium* and *aspergillus niger* for (A, a) 0 day, (B, b; E, e) 30 days, (C, c; F, f) 60 days and (D, d; G, g) 90 days.

Conclusions

Penicillium and *aspergillus niger* are the two most common fungi that cause leather microbial aging. The metabolites of *penicillium* and *aspergillus niger*, such as enzymes, acids and other substances, hydrolyzed the grain layer, resulting the broken of the pore structure of the leather grain layer. After aging, the TA were decomposed as well as the collagen of TA-tanned leather was broken. Therefore, the tensile properties of TA tanned leather are reduced.

References

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Acknowledgments

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