STUDY REGARDING THE RESISTANCE OF ORGANIC TANNED WET-WHITE LEATHER TO THE GROWTH OF FUNGI

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The paper presents the resistance of wet-white leather organic tanned with oxazolidine and resorcinol to the growth of fungi. Wet-white leather was characterized for microbiological resistance using an inoculum with 4 species of fungi: ATCC 6275 of *Aspergillus niger, Trichoderma viride, Aspergillus oryzae* 153 and *Mucor pusillus*. Wet-white leather samples tanned with resorcinol-oxazolidine are attacked by *Aspergillus niger* and *Mucor pusillus*, but inhibit growth of moulds from *Aspergillus oryzae* and *Trichoderma viride* species. This type of leather can also be damaged by mould from the *Penicillium* genus.

Keywords: organic tanned wet white leather, microbiological testing, fungi

INTRODUCTION

The deep interest of tanners in clean technologies has led to increased efforts to develop chrome-free tanning agents. Most of the leather produced today around the world is chrome tanned and the total leather production system, starting with the beam house and including dyeing, retanning and fat liquoring, has been adjusted and developed to its present high level around chrome tanning. But chromium is considered toxic for human health. The single solution for this problem is finding out an environmentally friendly alternative to chromium tannage. Alternative free of chrome (FOC or wet white) tanning technologies include the use of tanning agents based on organic compounds like oxazolidine, which in combination with other retanning agents of vegetable or synthetic origin, allow for obtaining quality leathers that may be used by footwear industries. Wet-white refers to partially processed leathers that have been tanned with resorcinol/oxazolidine, but not dyed, dried or fat-liquored yet (Lanxess; Padoan, 2006; Adiguzel Zengin *et al.*, 2012; Liu *et al.*, 2010; Platon *et al.*, 2010; Roig *et al.*, 2011; Deselnicu *et al.*, 2014).

Wet-white leathers are excellent substrates for fungal growth: storage temperature, acid pH, presence of water, proteins and fats constitute the most important conditions for the development and growth for a lot of moulds, such as *Penicillium* spp., *Aspergillus* spp. and *Trichoderma viride*. The fungal contamination appears as coloured stains on the leather, usually permanent.

Usually leathers are preserved against fungi with fungicides (Tarlea *et al.*, 2009).

This study aims at testing fungal resistance of wet white organic tanned leather with resorcinol-oxazolidine.

MATERIALS AND METHODS

Materials

Samples: specimens of wet-white leather were obtained after tanning stage of bovine hides using resorcinol-oxazolidine tanning (Deselnicu *et al.*, 2012a; 2012b).

Biological material: 4 fungi strains were used: *Aspergillus niger* ATCC 6275, *Trichoderma viride*, *Aspergillus oryzae* 153 and *Mucor pusillus.*

Culture medium: Potato Dextrose Agar (PDA) culture medium was used.

Methods

Microbiological tests were performed according to ASTM standard D 4576-08 (2013) - Test Method for Mold Growth Resistance of Wet Blue. Four samples of each type of leather were inoculated with each of the 4 fungi strains and were incubated at 28 ± 1°C for 28 days. Leather samples were evaluated after 7, 14, 21 and 28 days to determine fungi growth, ranking them from 0 to 4, as follows: mark 0 for leathers not covered by mould, mark 0.5 for growth on less than 12% of the sample surface, mark 1 for growth ranging between 12 and 25% of the surface, mark 2 if 50% of the sample surface is covered by fungi, mark 3 if mould grew on 75% of the sample surface and mark 4 if the sample is entirely covered by mould.

Chemical tests of wet-blue and wet-white leathers were performed according to EN ISO standards.

RESULTS AND DISCUSSIONS

Chemical characteristics of wet-white leathers are shown in Table 1.

Table 1. Wet-white leather characteristics

No.	Characteristics	Wet-white organic tanned leathers
1	Shrinkage temperature, °C	70-74
2	Grease, %	4.5
3	pH	4.3
4	Moisture, %	55.0
5	Ash, %	10.5
6	Total nitrogen, %	12.9

Table 2 presents the appearance and assessment (marks) of leather samples after 7, 14, 21 and 28 days. According to the working standard, samples were evaluated ranking them from 0 to 4 depending on the growth of mould on the sample (Table 2). The following were found:

After 7 days *Aspergillus niger* grew on the entire surface of the organic tanned wet white leather sample; the organic tanned wet-white leather sample inhibited growth of *Aspergillus oryzae* and *Trichoderma viride*.

Mucor pusillus only grew in the culture medium around the wet-white leather samples.

After 14 days, *Aspergillus niger* grew on the leather, while the growth of *Aspergillus oryzae* was further inhibited by the wet-white leather sample tanned with resorcinol-oxazolidine.

The growth of *Trichoderma viride* colonies was inhibited by the leather sample tanned with resorcinol-oxazolidine, but a colony of *Aspergillus niger* spontaneously appeared on the sample.

Wet-white leather samples were entirely covered by *Mucor pusillus*.

Table 2. Appearance and assessment of leather samples after 7, 14, 21 and 28 days

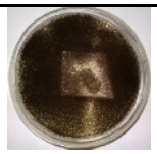
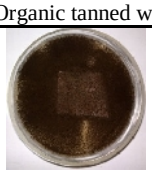
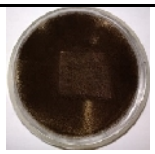
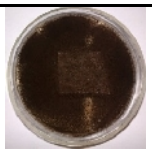
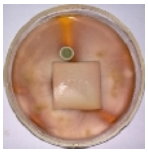
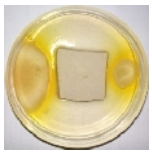
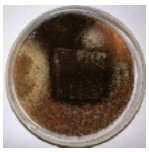
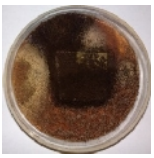
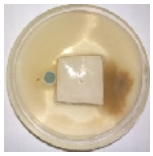
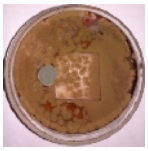
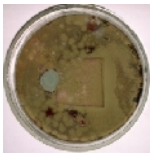
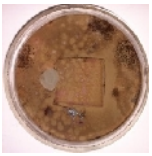
Fungus type	7 days / mark	14 days / mark	21 days / mark	28 days / mark
Organic tanned wet-white leather				
A. niger	 3	 4	 4	 4
A. oryzae	 0	 0	 0	 0
T. viride	 0	 0	 0	 0
M. pusillus	 0	 3	 4	 4

Figure 1. *Aspergillus niger* and *Aspergillus flavus* moulds spontaneously grown on the wet-white leather sample tanned with resorcinol-oxazolidine after 21 days

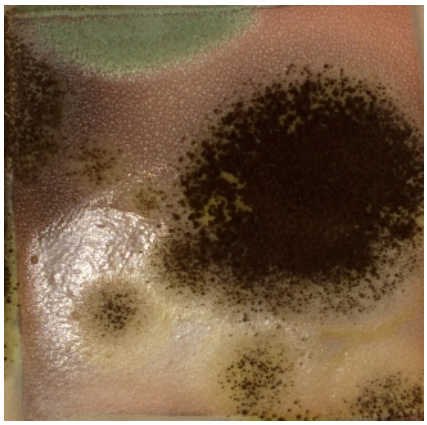


Figure 2. Appearance of the leather sample tanned with resorcinol-oxazolidine and inoculated with *Aspergillus oryzae* after 28 days

After 21 days, the leather samples inoculated with *Aspergillus niger* were entirely covered by mould; the situation of samples inoculated with *Aspergillus oryzae* remained unchanged, but two *Aspergillus niger* colonies and one *Penicillium* colony appeared, while the appearance of samples inoculated with *Mucor pusillus* did not change much. The leather sample tanned with resorcinol-oxazolidine completely inhibited the growth of *Trichoderma viride* colonies, but was entirely covered by *Aspergillus niger* and a colony of *Aspergillus flavus* also appeared (Figure 1).

After 28 days the appearance of samples inoculated with *Aspergillus niger* and *oryzae* did not change, except for the leather sample inoculated with *Aspergillus oryzae* (Figure 2) on the surface of which a *Penicillium* colony also grew, while *Aspergillus niger* colonies developed. The appearance of samples inoculated with *Trichoderma viride* and *Mucor pusillus* did not change much either.

CONCLUSIONS

Aspergillus niger and *Aspergillus flavus* are the most aggressive and invasive species, developing very rapidly, much quicker than *Trichoderma viride*, *Mucor pusillus* and moulds from the *Penicillium* genus, the latter having the slowest growth rate. Although it produces chitinases with antifungal effect, *Trichoderma viride* does not inhibit development of *Aspergillus niger* and *flavus* species.

Wet-white leather samples tanned with resorcinol-oxazolidine are attacked by *Aspergillus niger* and *Mucor pusillus*, but inhibit growth of moulds from *Aspergillus oryzae* and *Trichoderma viride* species. This type of leather can also be damaged by mould from the *Penicillium* genus.

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