OPTIMIZING ENZYMATIC DYEING OF WOOL AND LEATHER

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ABSTRACT

Wool and Leather have been dyed with "in situ" generated pigment by means of laccase-catalysed oxidative coupling of dye precursor ABTS and dye modifier Resorcinol in a batchwise process. The process reaction variables (laccase, precursor and modifier concentrations, temperature and dyeing time) were optimized for wool biocolouration. The temperature, precursor concentration, interaction between precursor and modifier, and time are the most important factors in the dyeing process. The best-optimized wool dying conditions (2h reaction time, 50µl laccase, 500mM mediator, 10mM precursor at 40ºC) were then successfully applied onto leather material. The enzymatic-dyeing optimized process can be successfully performed on wool and leather at low temperature and mild pH obtaining different hues and depths of shades by varying the modifier concentration and time. Moreover, the enzymatic-dye bath solution can be reused several times, which has a huge advantage in terms of cost reduction.

INTRODUCTION

In recent years, different studies have been conducted to apply the potential of enzymes as catalysts in textiles dyeing (Pezzella, 2016). Laccase (EC 1.10.3.2) belongs to the class of multi-copper oxidoreductases enzymes that oxidize colourless aromatic compounds such as phenols, aminophenols and diamines and to aryloxy radicals capable to undergo further non-enzymatic oxidation resulting in coloured dimeric, oligomeric or polymeric compounds (Mate, 2015). There are several publications focusing on the enzymatic coloration of wool, cotton and human hair by laccase via several reaction substitutes (Prajapati, 2018). However, only one publication using laccase-catalysed dyeing of leather without any optimization is available (Suparno et al., 2007). The present study intend to develop an alternative environmentally friendly process for colouring wool and leather avoiding the use of dyes and other chemicals used in the traditional dyeing process and all the problems associated with this type of recalcitrant compounds.

RESULTS AND CONCLUSIONS

The effects of variables were studied simultaneously, using a full factorial planning 2^5. The amount of colour in the wool is directly proportional to the values of K/S. When ABTS was added to laccase-polymerized resorcinol a clearly shift in color due to coupling and polymerization reactions can be observed. The response surface analysis for the values of K/S (Fig. 1) shows that it is possible to increase the value of K/S as it increases the concentration of precursor and modifier. The optimization point was with 2h reaction time, 50µl enzyme amount, 500mM mediator concentration, 10mM precursor concentration and 40ºC.

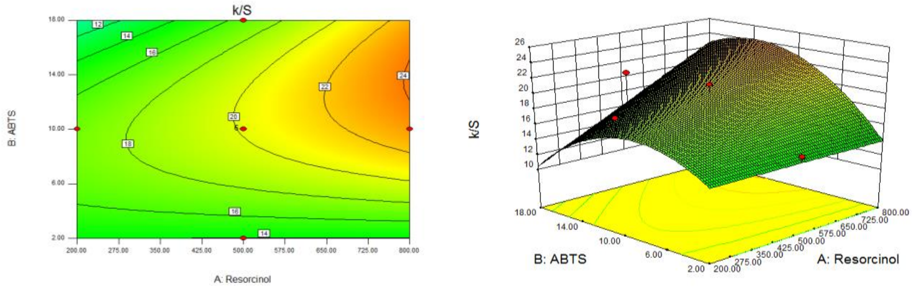

Fig. 1 Response surface for the effect of the concentration of modifier at the concentration of precursor for the response K/S.

In Figure 2 is possible to see the penetration of colour into the biocoloured wool fibres and an example of the colour palette that can be obtained in leather. The colouring enzymatic system has a good reusability, washing durability and is comparable in terms of fastness properties to the traditional dyeing process for both wool and leather**.** The characterization tests showed that the process is an economically attractive alternative to the conventional dyeing method, characterized by the high consumption of water, dyes, auxiliaries and energy.

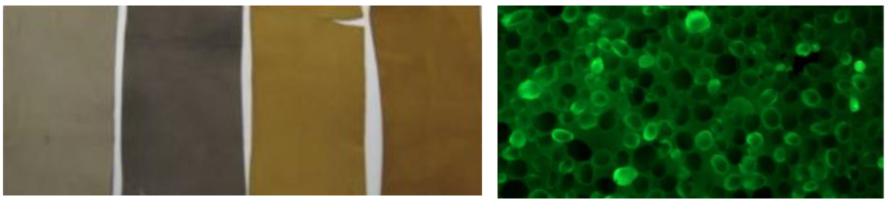

Fig. 2 Colour palette variation of the biocoloured leather (Left) and fluorescence microscopic image of the cross section of the wool fibre with 23µm (Right)

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