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Editorial

Biotechnology in the textile industry—perspectives for the new millennium

Retting of flax was the first biotechnological application in textile processing. More than 2000 years ago, micro-organisms grown on flax were used to achieve partial decortication in the extraction of linen fibres from flax stems. Amylases were the only enzymes applied in textile processing until the 1980's. These enzymes are still used to remove starch-based sizes from fabrics after weaving.

Research on enzymatic applications in textile processing dates back to the beginning of the last century. During this period, the potential of proteolytic enzymes was assessed for the removal of wool-fibre-scales resulting in improved anti-felting behaviour. Despite the fact that investigations in this area are still on going, an industrial process has not yet been achieved. This is largely attributed to the heterogeneous nature of textile fibres and the unacceptable fibre strength losses incurred. With the advent of biological detergents in the 1960s, proteases made their way into detergent formulations specifically to remove organic protein-based stains (e.g. from egg, blood) from textile garments. Later in the 1970s, cellulases were found to add detergency during fabric washing and to remove fibrillation in multiple washes. Today, cellulases are included in many washing powders. Cellulases have also been employed to enzymatically remove fibrils and fuzz fibres and have also successfully been introduced to the cotton textile industry and later for lyocell processes. Further applications have been found for these enzymes to produce the aged look of denim and other garments.

In May 2000, the First International Symposium on Biotechnology in the Textile Industry was held in Portugal and was attended by more than 150 participants from all over the world. The presentations given at this forum by scientists and delegates from industry reflected the enormous potential of Biotechnology in the textile field. Advances in biotechnology have made it possible to tailor special enzyme mixtures for specific applications. For example, amylases have been developed for desizing processes running at 100 °C while cellulase monocomponents were identified to be superior to the native enzymes in several textile applications. Besides hydrolytic enzymes such as cellulases, amylases, pectinases (bioscouring) and proteases (wool finishing), other enzyme activities including oxidoreductases have been realised as powerful tools in various textile-processing steps.

Several studies dealing with cellulases are presented in this special issue. By focusing on process development and the control of enzymatic fibre hydrolysis this research strives to find a balance between the beneficial effects of enzyme treatments and the potential strength losses. A number of investigations have dedicated their efforts to the phenomenon known as back staining, experienced during bio-stoning and bio-finishing of both

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cotton and linen fabrics. Other authors took the great challenge to elucidate the degradation mechanism of the natural substrates of cellulases. The effect of endoglucanases and cellobiohydrolases from different sources were used for these investigations together with components of these enzymes. The results of these contributions combined with information about the molecular architecture and specificities on soluble substrate of cellulases from different families will improve our understanding of the functioning of this interesting class of enzymes. Although fibres from cotton were the main target substrates for enzymatic modifications introduced in the last few years, enzymes also seem to have a potential for the improvement of fibres/fabrics from other sources such as flax and wool. Two interesting contributions show how enzymes can be used both in flax processing and analysis. Besides enzymes, the biopolymer chitosan can be used to improve the properties of wool.

Biotechnological processes for the treatment of textile effluents can be grouped into two areas, microbial systems and enzymes. In microbial effluent treatment, a combination of anaerobic and aerobic steps seems to be beneficial in achieving sufficient detoxification. New more efficient treatment processes and their integration into textile finishing are discussed in several of the following papers. Ligninolytic enzymes such as laccases, lignin peroxidases and manganese peroxidases have been shown to decolourise textile dyes involving either polymerisation or degradation of dyes. The mechanisms of decolorisation and detoxification have been described for several dyes, including azo compounds. However, although some azo dyes were degraded with concomitant conversion of the azo group into molecular nitrogen (harmless), these enzymes did not attack some dyes at all. It appears that the redox potential rather than steric effects seem to determine the degradation velocity. Another interesting application of enzymes for textile effluent treatment involves the use of catalases for the conversion of hydrogen peroxide present in bleaching effluents to oxygen and water. Both this process and enzymatic treatment of dyeing effluents have been shown to enable recycling of the process waters, especially when immobilised enzymes had been used.

While in the last number of years several new biotechnological methods such as biostoning or bioscouring have been successfully introduced to the textile industry, other processes including enzymatic effluent treatment and biofinishing wool are not yet used on an industrial level. Continuing research in biotechnology related to textile applications should lead to the employment of many of these new eco-efficient technologies in the textile industry during this decade.

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