Researchers discover superior enzyme for water purification

A team from the enzyme technologies research group at CSIR Biosciences has discovered a unique laccase that is superior to that used by commercial companies. The laccase bodes potential success in the treatment of wastewater on an industrial scale. Laccases are copper-containing oxidase enzymes found in many plants, fungi and micro-organisms and are commonly applied in textile dyeing or finishing, wine cork making and for other industrial, environmental, diagnostic and synthetic purposes. The studies may result in an alternative method of water purification for agricultural production.

"This enzyme has shown excellent wastewater treatment capacity," says Dr Kevin Wellington, a senior research chemist. Other team members include Dr Dean Brady, Dr Justin Jordaan, Daniel Visser, Clinton Simpson and Tshwane Manchidi. They are now concentrating on over-expression of the enzyme.

"The laccase enzyme has shown promise in the decolourisation of wastewater containing textile dyes. These dyes are often phenol derivatives," explains Wellington.

Conventional methods of dephenolisation of industrial wastewater include solvent extraction, adsorption onto activated charcoal, microbial degradation and chemical oxidation. "These methods are useful but have some drawbacks such as high cost, incomplete purification, formation of hazardous by-products or restricted applicability to pollutants. Other approaches are needed such as enzymatic methods of treatment," he says, adding: "Laccases catalyse the oxidation of phenols (previously known as carbolic acid - it is a toxic, colourless crystalline solid and a class of organic compound) to form dimers (a molecule composed of two identical subunits or monomers linked together), which eventually result in higher oligomers and polymers of low solubility". "The fungus or the crude or pure enzyme can be used for these reactions. The resulting polymers precipitate and can be removed by sedimentation or filtration. Laccase thus has a strong potential for application in the purification of wastewater."

According to Wellington, the most important obstacles to commercial application of laccases are the lack of sufficient enzyme stocks and the cost of redox mediators. Progress has, however, been made over the past few years to solve these problems and it is expected that laccases will be able to compete with other processes such as elemental chlorine-free (ECF) and totally chlorine-free (TCF) bleaching.

"Many of the enzymes that we have investigated as biocatalysts for industrial purposes also have potential as bioremediation agents," he says.

The group presented a poster on its research at the CHEMRAWN (Chemical Research Applied to World Needs) XII conference at Stellenbosch University, which ran from 2-5 December. It was themed 'The role of chemistry in sustainable agriculture and human well-being in Africa'.