Imidazole-rich copper peptides as catalysts in xenobiotic degradation

ABSTRACT

Laccases, oxidative copper-enzymes found in fungi and bacteria were used as the basis in the design of nona- and tetrapeptides. Laccases are known to be excellent catalysts for the degradation of phenolic xenobiotic waste. However, since solvent extraction of laccases is environmentally-unfriendly and yields obtained are low, they are less preferred compared to synthetic catalysts. The histidine rich peptides were designed based on the active site of laccase extracted from Trametes versicolor through RCSB Protein Data Bank, LOMETS and PyMol software. The peptides were synthesized using Fmoc-solid phase peptide synthesis (SPPS) with 30–40% yield. These peptides were purified and characterized using LC-MS (purities >75%), FTIR and NMR spectroscopy. Synthesized copper(II)-peptides were crystallized and then analyzed spectroscopically. Their structures were elucidated using 1D and 2D NMR. Standards (o,m,p-cresol, 2,4-dichlorophenol) catalysed using laccase from Trametes versicolor (0.66 U/mg) were screened under different temperatures and stirring rate conditions. After optimizing the degradation of the standards with the best reaction conditions reported herein, medications with phenolic and aromatic structures such as ibuprofen, paracetamol (acetaminophen), salbutamol, erythromycin and insulin were screened using laccase (positive control), apo-peptides and copper-peptides. Their activities evaluated using GC-MS, were compared with those of peptide and copper-peptide catalysts. The tetrapeptide was found to have the higher degradation activity towards salbutamol (96.8%) compared with laccase at 42.8%. Ibuprofen (35.1%), salbutamol (52.9%) and erythromycin (49.7%) were reported to have the highest degradation activities using Cu-tetrapeptide as catalyst when compared with the other medications. Consequently, o-cresol (84%) was oxidized by Tp-Cu while the apo-peptides failed to oxidize the cresols. Copper(II)-peptides were observed to have higher catalytic activity compared to their parent peptides and the enzyme laccase for xenobiotic degradation.