# USE OF THE LACCASE IN BIOREMEDIATION

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**Abstract** - Laccase is an example of multicopper enzymes and it is blue in colour. Itcatalyses oxidation reaction via one electron transfer. The laccase converts oxygen to the water with electronic reduction. Thelaccaseisconservationist, sustainable, environmentallysound, multifaceted and flexible biocatalyst and these properties makes it an interesting area of research in the field of biotechnology. Laccases are also used in industries such as processedfood, beverage industry and in the field of the medical diagnosis. Laccases are used in the construction of furniture because they have the properties of cross-linkingand are also useful in the production biofuel from lignocellulosics. The bioremediation methods of chemical, physical and biological origin have been employed to keep the environment clean and pollution free, but these methods were proven to be insufficient to clean the environment. Bioremediation which is based on the enzyme is a versatile approach. The xenobiotic compounds are uncooperative and intractable and their bioremediation is done on the basis of enzymatic degradation. Several microbial enzymes were taken from different sources and were characterized. The bioremediation capability has led to the isolation of the various microbial enzymes. A large number of the recombinant enzymes have been formed due to high potentiality and the prospects of genetic engineering. The stability and enzyme activity of the enzymes can be enhanced by enzyme immobilization.

**Keywords** - Bioremediation, Enzyme Immobilization, Xenobiotics, Laccase, Environment, Biodegradation

## I. INTRODUCTION

Laccases (EC 1.10.3.2: benzenediol: oxygen oxidoreductase) are the multicopper enzymes that degrade lignin[1]. A large number of aromatic compounds are oxidized when the reaction is catalysed by laccases in the presence of molecular oxygen. The oxidation reactions are catalysed by these enzymes and molecular reduction via four electrons transfer takes place in which molecular oxygen is reduced to water[2].

Laccases are disseminated in plants [3], fungi [4]. Laccases have also been reported in lichens and in sponges. The origin of laccase and the organism from which it is produced regulates and governs the biological activity of the enzyme. Stress defence involves use of fungal laccases. Plant pathogens and degradation of lignin also involve the fungal laccases [5].The morphogenesis,pigmentation and protection against the oxidizing agents are done with the help of bacterial laccases.The aromatic compounds such as ortho and para diphenols,methoxy substituted phenols, are included as a substrate of the laccases[6]. Ligninolytic enzymes are widely found in the atmosphere and examples of the ligninolytic enzymes are laccases [7,8].The binding of laccase takes place such as they bind to the reducing substrate and oxygen. Oxygen is in the central position and it is surrounded by four copper atoms which are catalytic in the nature. The copper of type 1 is paramagnetic in nature. Itis named as T1Cu. The protein exhibits a blue colour and the absorption is seen around 610 nm which detects the electron spin resonance. The second type of copper named as T2Cu is achromatic and it also detects the electron spin resonance. The third type of copper,T3Cu requires a longer path length and electron spin resonance is not observed [9]. The molecular oxygen is used by the laccase in order to oxidize a variety of aromatic compounds and this mechanism takes place via radical intermediates. The phenolic and non-phenolic abstracts are also catalysed by laccase. The aryloxy radicals are formed when the phenolic substrate is oxidized by laccase. The aryloxy radicals gets transformed into the quinone when the oxidation takes place again after the first oxidation.

The polyamines,aminophenols,lignin aryl diamine can corrode the different types of substrate which are of lignin origin [10].The formation of quinone doesn't takes place by the substrate ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) and it is not dependent on acidity or alkalinity of the enzyme and therefore it is used to measure the international activity unit of laccase. The percentage of carbohydrates that is accommodated and quelled by the laccase is about 15 -20 %. The molar mass of laccase is of the order 60-90 kDa. The point of zero charge of laccase is about pH 4.0 and hence the enzyme laccase exhibits the solidity and the stoutness [11].The majority of swotting and cramming of white rot fungus has been enthralled and enrapted. A higher thermal resistance was shown at pH 4.5 by the white rot fungus [12].Trametesversicolor in the provision of the dyestuff colourant blanching [13].The Phanerochaetechrysosporiumwas found to be more productive with the elevated level of production of laccase for the medium which is solid in nature. The starting point and the provenance of the

contamination and the befouling can be recognized and pinpointed by the commercial undertakings, armament and arsenal which was left over and was found to be superfluous (Figure 1).

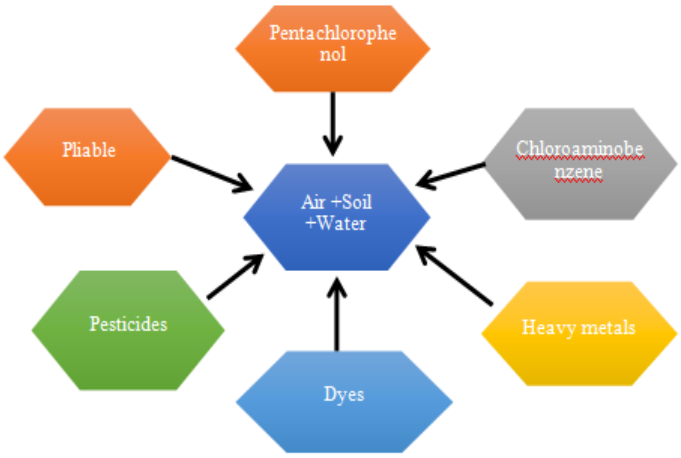



**Figure 1: Adulterations in the surroundings caused by the organic and inorganic compounds**

## II. ACCELERATED BIODEGRADATION AND EXTRACELLULAR ENZYMES

The belongings to the substantial modification of the composition of the toxic pollutants or to lapidify the biological particle on to the harmless inorganic finished results. "As far as the exceptional and substantial variance of the xenobiotics configuration among the midst of the amalgamation fabricated in the nature, the smaller is the plausibility of noteworthy abasement" [14]. The PAH present in the pollutants is oxidized in the presence of enzymes and formation of simple product takes place. This product has higher solubility and the degradation takes place at a rapid pace [15].The microorganisms associated with the roots are affected when the xenobiotic biodegradation takes place in the rhizosphere [16].The oxidases and the hydrolases are liberated by the family of the Fabaceae, Gramineae and Solanaceae. The PCB i.e. polychlorinated biphenyls is pernicious to the plant and the production of the peroxidase[17].The peroxidases were produced by the cultures of Ipometabatadaand their isoelectric points varied from 3 to 9[18].The microbial oxidoreductases come under the category of the periplasmic enzymes and these oxidoreductases correlate the surface of the living cells. The major provenances of the oxidoreductases are the fungi such as the Basidiomycetes which degrade the wood, ectomycorrizalfungi. These fungi are cultivated and are considered as the negotiators of the bioremediation [19-22]. A large number of the environmental pollutants are also oxidized by the lignin degrading system [23,24]. Cellobiose dehydrogenases are non-ligninolytic enzymes which take part in the modification of the substances which are contaminating [25,26].

## III. MICROBIAL HYDROLASES

Hydrolases are the class of microbial enzymes which actively participate in the transformation of pollutants. The class of ecto or extracellular enzymes are produced by the classes of bacteria as well as fungi. For example: proteases, carbohydrases,esterases, phosphatases. Living organisms require enzymes for their physiological needs. Theconversion of large molecules such as proteins and carbohydrates into the small molecules takes place by the enzymes. Plants and the microbes get nutrition by converting the organic phosphate compound into the inorganic phosphate. This inorganic phosphate is readily accumulated by the plant cells. The record of the microbial hydrolases which are bewildered in transforming the natural and non-natural compounds which are insoluble, is listed is table1.

| Type of the sources | Enzyme | Microorganisms | References |
|---|---|---|---|
| Cellulose material | Cellulase | Trichodermaresei, Penicilliumfuniculosum | [27] |
| Chitin | Chitinase | Actinobacteria | [28] |

| | | | |
|---|---|---|---|
| Keratin | Keratinase | Chysosporiumkeratinophilum | [29] |
| Starch materials | Amylase | Bacillus licheniformis | [30] |
| Polyacrylate | Cellobiose Dehydrogenase | Whie-rot fungi | [31] |
| Polyurethane | Esterase | Curvulariasenegalensis(not wrf), Corynebacterium, Comamonasacidovarans | [32-34] |
| Polyvinyl alcohol | Esterase,laccase | Pseudomonas vesicularis, Pycnoporuscinnabarinus | [35,36] |

**Table 1:The disintegration of the natural and the non-natural insoluble materials by the microbial hydrolases.**

The environment consisting of the solid wastes is found to be augmented by the wastes which are keratinic in nature and various products that are made of paper. The utilization of the cellulase was outlined by Van Wyk [37]. He exemplified that cellulases among Penicillumfunicolosumand Tricodermareseimodified and altered the materials made of the paper. The chitinases belongs to the group consisting of the bacterial hydrolases and they catalyse the β 1-4 glycosidic bonds made of the chitin [38].

## IV. BIOREMEDIATION AND FREE ENZYMES OF THE CELL

The onset of the degradation of the pollutant takes place in the presence of the extracellular enzyme. The enzymatic supplication and the approach have been implemented in the solid, liquid treatment and it has been documented by Nicell [39].

The lignin peroxidase,laccase was obtained from the white rot fungus Nematolomafrowardii[40]and these enzymes oxidized the ring of aromatic compounds such asanthracene, pyrene etc.Tsutsumi et al documented that the oxidases which were of fungal origin, their uses were seen with the chemicals which were estrogenic in nature.

| Hazardous waste | Enzymes | Origin | Resources | References |
|---|---|---|---|---|
| Anthracene | Laccase | Nematolomaforwardii | High | [40] |
| Carbofuran | Carbamate hydrolase | Achromobactersp. | specific | [40] |
| Estrogenic chemicals | Laccase | Trametesversicolor | 70-100% transformation | [40] |
| Nitrile compounds | Nitrilase | Fusariumsolani | pH 6 to 11 | [41] |
| Lindane | Laccases | Several microorganisms | Stereospecific | [41] |
| Phenols | Laccases | White rot fungi | Very flexible | [42] |
| Diazinon | -- | Agrobacterium | pH 5.5-10 | [42] |

**Table 2: Cell-free enzymes degrading the pollutants.**

## V. CONCLUSION

The enzyme gets immobilized on the components of the soil. Theenzymes participate as a catalyst and help in degrading the poisonous pollutants. The efficiency of enzyme is affected by the presence of substances which are heavily polluting. Enzymes activity was found to be more when they were immobilized under soil conditions. Laccase mediated systems are very helpful in degrading poly phenolic toxicants.

### Conflict of Interest

The author declares no conflict of interest, financial or otherwise.

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