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Application of Various Enzymes in Waste Treatment

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ABSTRACT

The implementation of increasingly stringent standards for the discharge of wastes on to the environment has necessitated the need for the development of alternative waste treatment processes. A review of research directed toward developing enzymatic treatment systems for solid, liquid and hazardous wastes are presented. A large number of enzymes from a variety of deferent plants and microorganisms have been reported to play an important role in an array of waste treatment applications. Enzyme can act on specific recalcitrant pollutants to remove them by precipitation or transformation to other products. They also can change the characteristics of a given waste to render it more amenable to treatment or aid in converting waste material to value- added products. Before the full potential of enzymes may be realized, it is recommended that a number of issues be addressed in future research endeavors including the identification and characterization of reaction by products, the disposure of reaction products and reduction of the cost of enzymatic treatment.

I. INTRODUCTION

Considerable research has been conducted during the past two decades to investigate the new possibilities offered by enzymes in waste treatment. In recognition of these potential advantages recent research has focused on the development of enzyme process for the treatment of waste waters solid wastes hazardous wastes and soils the objective of this review are to provide a summary of the enzyme research in a area of waste treatment and briefly assess the potential of these enzymes for future full scale application.

PHENOLIC CONTAMINANTS AND RELATED COMPOUNDS:

Aromatic compounds including phenols and aromatic amines constitute one of the major classes of pollutants and are heavily regulated in many countries they are found in the waste water of a wide variety of industries including coal conversion petroleum refining resins and plastics wood preservation metal coating dyes and chemicals a member of enzymes have been successfully used and will be presented in the following sections.

Peroxidases: Peroxidases are oxidoreductase produced by a number of microorganisms and Plants. They all require the presence of peroxides such as H_2O_2 to active them.

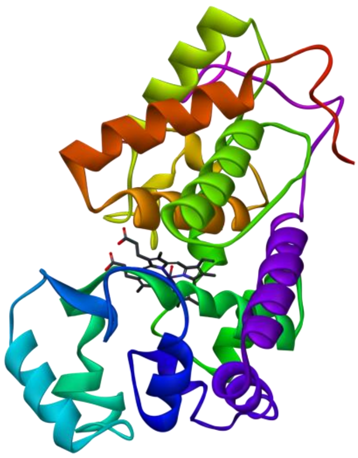

Figure 1

A. Horseradish Peroxidases: HRP is undoubtedly one of the most studied enzymes in the relatively new area of enzymatic waste treatment once activated by H_2O_2,

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HRP can catalyses the oxidation of a wide variety of toxic aromatics compounds including phenols, biophenols, anilines, benzidines and related hetero aerometric compounds. In addition HRP has the ability to co precipitate certain difficult to remove contaminants

B. Other Peroxidases: Chloroperoxidase from the fungus caldariomyces fumago, Manganese peroxidase produced by phanerochete chrysosporium, Microbial peroxidase from coprinus macrorhizus as an alternative to HRP, Plant peroxidase extracted from tomato and waterhyacinth plants.

(2) Polyphenol Oxidses: Polyphenol oxidases represent another family of oxidoreductase that has also been shown to catalyze oxidation reaction of phenolic compounds. They are subdivided in to two subclasses:

A. Tyrosinase: Tyrosinase also known as polyphenol oxidase, phenolase or catecholase, catalyse two consecutive reactions: (1) The hydroxylation of monophenols with molecular oxygen to form o-diphenols (2) The dehydrogenation of o-diphenols with oxygen to form o-quinones.

B. Laccase: Laccase is produced by several fungi and seems capable of decreasing the toxicity of phenolic compounds through a polymerization process.

PULP AND PAPER WASTES:

Figuer 2

(1) Peroxidases and Laccase: The Kraft process which is widely used in wood pulping leaves 5-8 % (w/w) of residual modified lignin in the pulp. This residual is responsible for the characteristic brown color of the pulp and is commercially removed by the use of bleaching agents such as chloride and chloride oxides. Bleaching operations produce dark brown colored effluents which contain toxic and mutagenic chlorinated products that constitute an environmental hazard.

Laccase has also been cited as a possible candidate For bleaching plant effluent treatment. Whereas enzyme Used in their free form caused a slight depolarization,immobilization enzymes had a more pronounced result.

(2)Cellulolytic enzymes: There have been some Reports on the use of Cellulolytic enzymes in the Treatment of sledges' from pulping and deinking operations. Since an average of 60 kg of primary sludge are generated per ton of pulp produced, ethanol production is evidently an attractive way of decreasing the amount of sludge that has to be handled and disposed of while producing a saleable product.

The enzymes used included a blend of cellobiohydrolase, cellulase and β-glucosidase.

PESTICIDES:

Figure 3

Pesticides, which include herbicides and fungicides, are widely used throughout the world today for crop protection and it is expected that this use will continue to grow. The potential adverse effects that the pesticide industry can have on the environment arise from the disposal of wastes formed during production and formulation of pesticides, detoxification of pesticide containers and spray tanks, and the pollution of surface and ground water by pesticide runoff.

Perathiolhydrolase, also known as phosphotriesterase has been proposed for pesticide detoxification and seems to represent a viable alternative to the more common treatment method perathiolhydrolase is produced by a number of bacteria including pseudomonas species, flavobacterium species and a recombinant straptomyces.

CYANIDE WASTES:

It is estimated that 3 million tons of cyanide are used yearly Throughout the world in different industrial processes including The production of chemical intermediates, synthetic fibers, Rubber and pharmaceuticals, as well as in ore leaching, coal Processing and metal planting. Since cyanide is a metabolic Inhibitor and can be lethal to humans and other organisms, it is Essential that it be removed from effluents prior to discharge.

(1) Cyanidase: Cyanidase is a new enzyme preparation capable of converting cyanide in industrial waste waters to ammonia and format in what appears to be a single step reaction. Cyanidase is based on certain gram genitive bacteria isolates from the species alcaligenes denitrificans and it is prepared by proprietary methods.

(2) Cyanide hydratase: Cyanide hydratase, also known as formamide hydrolyase, has been reported to hydrolyze cyanide to formamide. Cyanide hydratase is produced by a variety of fungi and is inducible upon pre-exposure of the fungi to low concentrations of cyanide.

Figure 4

FOOD PROCESSING WASTES:

The food processing industry is a major industry that produces vary large amounts of wastes.

Figure 5

The food processing industry is a major industry that produces very large amounts of wastes. Enzyme could be used to decrease food wastes via enzymatic processing to yield higher value by- product and to aid in the clean-up of food waste streams.

(1)Proteases: Protease is group of hydrolases which are widely used in the food industry in processing fish and meet waste. Proteases can solubilize proteins in waste streams, resulting in recoverable liquid concentrates of dry solids of nutritional value of fish or live-stock. Proteases hydrolyze insoluble proteins through a multi step process whereby the enzyme, which is initial, absorbed on the solid substrate of polypeptide chains that are loosely bound to the surface. Then, the solubilization of the more compact core occurs at a slower rate dependant on the diffusion of the enzyme to surface active sites and core particles.

(2)Amylase: Amylases are polysaccharide hydrolases that have been used in the simultaneous saccharification and fermentation of starch and the treatment of starch-containing food wastewaters. Amylases could be used to produce alcohol from rice processing wastewater. α-amylase and glucoamylase in the production of photodegradable and biodegradable plastics. The process used involves the conversion of the starchy material contained in cheese whey or potato waste from commercial food processing to truly biodegradable plastics.

SOLID WASTE AND SLUDGE TRETMENT:

Figure 6

For the past decade, there has been an increasing Interest in the enzymatic hydrolysis of cellulose. This interest stems from the advantages that such a Process would offer, namely, the conversion of Lignocellulosic and cellulosic wastes to a useful energy source through the production of sugars, ethanol, biogas or other energetic end products.

Still, there have been numerous reports on the possible ways of improving the enzymatic hydrolysis of the cellulose contained in the organic fraction of municipal solid wastes (MSW) in order to produce fermentable sugars and eventually ethanol or butanol. Another study involving the fungal enzyme preparation "Econase" was conducted to investigate the effect of cellulolytic enzymes on MSW degradation. Apart from the interest in the hydrolysis of MSW cellulosic components, there has been some work done concerning the use of enzymes to improve sludge dewatering. Cellulase and the bacterial enzyme lyzozyme or muramidase, for sludge dewatering. While cellulase was used with penicillin and gave rather poor results, lyzozyme was allegedly able to alter flock matrices and to cause a dramatic increase in dewatering rates.

REMOVAL OF HEAVY METALS:

Figure 7

fuel reprocessing industries. Removal of cadmium, lead, copper, uranium and strontium was thus successfully achieved. The process involves the use of Citrobacter sp. cells immobilized in polyacrylamide gel, through which metal-containing solutions are passed. A cell-bound phosphatase, induced during pregrowth by providing the substrate glycerol 2-phosphate as a sole phosphorus source, liberates inorganic phosphate in excess of that needed for growth. The latter, in turn, combines with the metal to form an insoluble metal phosphate at the cell surface. It was reported that more than 90% metal removal was observed and that the metal could be recovered from the immobilized cells which could be reused.

OTHER POTENTIAL APPLICATIONS:

(1) Soil decontamination: it is possible to enhance the natural process of xenobiotics binding and incorporation into humus by adding enzymes such as laccase to contaminated soils. Laccases from Trametes versicolor, Rhizoctonia praticola and other fungi have been used to enhance the binding through oxidative coupling of various chlorinated phenols and aromatic amines with phenolic humic constituents. The advantages of such a process would be to immobilize and detoxify hazardous compounds.

(2)Surfactant degradation:

TREATMENT COST:

In order to successfully implement an enzyme-based treatment, the cost of the enzymes is of prime importance. The enzymes that are presently being investigated are expensive because of the cost of their isolation, purification and production. However, this fact should by no means hamper the effects to carry out more extensive research to identify the most promising enzymes and determine the optimal conditions for their use. In fact, the results of such research would provide the incentive for commercial development to eventually achieve large-scale production of the enzymes at a much lower cost. The direct use of plant material as an enzyme source represents a very interesting alternative to the use of purified enzymes due to its potentially lower cost. However, further studies are needed to conform the feasibility of such a process.

II. REFERENCES

[1]. Nicell, J. A., Al-Kassim, L., Bewtra, J. K. & Taylor, K. E., Wastewater treatment by enzyme catalysed polymerization and precipitation. Biodeterioration Abstracts, 7(1) (1993) 1, 1È8.

[2]. Aitken, M. D., Waste treatment applications of enzymes: opportunities and obstacles. T he Chemical Engineering Journal, 52 (1993) B49ÈB58.

[3]. Siddique, M. H., St. Pierre, C. C., Biswas, N., Bewtra, J. K. & Taylor, K. E., Immobilized enzyme catalyzed removal of 4-chlorophenol from aqueous solution. Water Research, 27(5) (1993) 883È90.

[4]. Nicell, J. A., Bewtra, J. K., Biswas, N., St. Pierre, C. & Taylor, K. E., Enzyme catalyzed polymerization and precipitation of aromatic compounds from aqueous solution. Canadian Journal of Civil Engineering, 20 (1993) 725È35.

[5]. Nicell, J. A., Kinetics of horseradish peroxidase-catalysed polymerization and precipitation of aqueous 4- chlorophenol. Journal of Chemical T echnology and Biotechnology, 60 (1994) 203È15.

[6]. Klibanov, A. M., Enzymatic removal of hazardous pollutants from industrial aqueous effluents. Enzyme Engineering, 6 (1982) 319È23.