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ENZYMATIC WASTE WATER TREATMENT

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ABSTRACT

Enzymes are biocatalysts provided by cells and are used in most metabolic methods. Most enzymes are consisting of proteins containing tertiary amino acid which bind to co enzyme or metal ions. Enzymes are accelerating biochemical processes by some mechanisms to chemical catalysts e.g. metals, metal oxides and metal ions. Enzymes can be very effective under conditions e.g. (temperature, atmospheric pressure and PH). Many enzymes have hydrolyzing, oxidizing and reducing characters. Enzymatic reactions always provide less side effects reactions and fewer waste by products. That is why microbial Enzymes can give an effective and environmental safe alternatives as metabolic inorganic chemical catalysts which can be used in all over pharmaceutical industrial processes. Enzymes are used in waste water treatment. Treatment technologies depend on physico-chemical approaches in wastewater treatment plants which require skills, high operation costs (in terms of high energy and chemical demand). Wastewater treatment is operated to protect the quality of limited freshwater resources, which are most times the final discharge points of effluents, and also, to promote the reusability of expended clean water; amounts of hazardous aromatic byproducts are still generated [3, 4]. The observation shows that wastewater treatment plants, though liable to remove microcontaminants such as heavy metals, and to a far lesser extent, aromatic contaminants, were originally structured for the removal of solid wastes, ecofriendly organic matter and eutrophication stimulants from wastewater, thereby reducing eutrophicating pollution loads; the micropollutants may only be moderately affected by the chemical, physical and biological interactions within the treatment plants.

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Introduction. Most Pharmaceutical industries release their chemicals and waste toxic water into the environment. This is leading to a very limited chance to obtain fresh water and worse human health on the earth. This is calling the world to look forward for a proper waste management system. Chemicals, industrial dyes, pharmaceutical active constituents, phenols, dioxins, chlorinated organic compounds and hydrocarbons are excreted in the water and affect human body health. It can cause side effects on body as allergy, headache and fever. To overcome all this problems by application of enzymatic waste water treatment.

Classification of microbial enzymes.

Enzymes are classified into many groups depend on the reactions they are catalyzed.

The enzymes that are used in pharmaceutical industrial waste water treatment process are

1. Microbial OXYGENASES:

These enzymes belong to oxidoreductase group of enzymes. It participates in oxidation of reduced substrates by transferring oxygen from molecular oxygen and utilizes FAD/NADPH as a co-substrate. These enzymes have a very important role in to increase the reactivity of organic compound or solubility in water. Oxygenases also mediate dehalogenation reactions of halogenated methanes, ethanes and ethylenes [11].

2. Microbial DIOXYGENASES:

Enzymes are using for oxidization of aromatic compounds and reflecting the applications of dioxygenases in the environmental treatment. Dioxygenases found in the soil of bacteria. It turns up aromatic precursors into aliphatic products.

3. Microbial MONOOXYGENASES:

These enzymes act as a catalyst in oxidative reactions of substrates from alkanes to complex molecules as steroids. They require only molecular oxygen for their activations and require substrates as reducing agent [12]. In desulfurization, dehalogenation, denitrification, ammonification of many aromatic and aliphatic compounds are catalyzed.

4. LACCASES:

These enzymes are produced by certain fungi, plants, insects and bacteria. These enzymes use for catalyze the oxidation of phenolic and aromatic substrates with molecular oxygen to water [12]. Many enzymes of laccases are capable of catalyze the amino phenols and inorganic ions.

5. MICROBIAL Peroxidases:

This enzyme is using in oxidation of phenols and lignin.

Table 1. Microbial enzymes and applications.

ENZYMES	APPLICATIONS
Alkylsulfatase	Surfactant degradation [32]
Amylase: • a-amylase • Glucoamylase	Starch hydrolysis and production of glucose [33]
Cellulolytic enzymes: • Cellulase • Cellobio-hydrolase • Cellobiase • Exo-1,4-b-D-glucosidase	Hydrolysis of cellulosic sludges from pulp and paper to produce sugars and alcohol, hydrolysis of cellulose in municipal solid waste to sugars and other energy sources [34]
Chitinase	Bioconversion of shellfish waste to N-acetyl glucosamine [35]
Chloro-peroxidase	Oxidation of phenolic compounds [36]
Cyanidase	Cyanide decomposition [37]
Cyanide hydratase	Cyanide hydrolysis [38]
L-Galactono-lactone oxidase	Conversion of galactose from whey hydrolysis to L-ascorbic acid [39]
Laccase	Removal of phenols, decolourization of Kraft bleaching effluents, binding of phenols and aromatic amines with humus [40]
Lactases	Dairy waste processing and production of value-added products [41]
Lignin peroxidise	Removal of phenols and aromatic compounds, decolourization of Kraft bleaching effluents[42]
Lipase	Improved sludge dewatering [43]
Lysozyme	Improved sludge dewatering [44]
Mn-peroxidase	Oxidation of monoaromatic phenols and aromatic dyes [45]
Parathion hydrolase	Hydrolyzation of organophosphate pesticides [46]
Pectin Lyase	Pectin degradation [47]
Peroxidase	Removal of phenols and aromatic amines, decolourization of Kraft bleaching effluents, sludge dewatering [48]
Phosphatase	Removal of heavy metals [49]
Proteases	Solubilisation of fish and meat remains Improving sludge dewatering [50]
Tyrosinase	Removal of phenols [51]

6. Microbial CELLULASES:

In the hydrolysis, cellulose can be applied for reducing the sugars which are fermented by yeasts or bacteria to ethanol [16]. Cellulases can be used for removal of cellulose microfibrils which can be appear during washing of cotton clothes. It also can be used for removal of ink during recycling of papers in the paper industries.

7.Microbial proteases:

It hydrolyzes peptide bonds. Use in many industries as food and pharmaceuticals.

8. Lipases:

It accelerates many reactions like hydrolysis and esterification. Can be use in many industries like food, detergent and cosmetics but on small scales due to its costs.

9.Tyrosinases:

Enzymes that catalyzes oxidation reactions. It can be used in the synthesis of melanin. It is also useful in treating phenol containing waste water. Their inability to oxidize phenolic compounds make them unuseful for environment and industries.

Materials and methods:

Enzymatic waste water treatment;

There are many physical and chemical technologies have been developed to treat waste water as coagulation, flocculation , reverse osmosis ,activated carbon adsorption and nano-filtration , however the cost of this treatments are so high .In recent years enzymatic methods of waste water treatment started to attract the attentions due to their low costs , simple equipments and they oxidize toxic pollutants e.g enzyme oxido reductase which catalyzes the oxidation-reduction reaction and can effectively treat dyes and phenolic compounds .There are also other process used for waste water treatment.

Immobilization method decrease the enzyme defects by increasing their immobilization. Advantages of immobilized enzymes in water treatment method that stability, enhance reuse and decrease costs. The simplest enzyme methods are to introduce cells to produce enzymes to the sewages which work by using of suitable micro organisms to co-metabolize wastes.

Nanotechnology is the method of waste water treatment applied by use nanoparticles in reactive remediation technology. This method characterized by degradation of toxic harmful compounds as carbon dioxide [53]. The treatment of waste water can be processed by using mix of enzyme technology and nanotechnology called the SEN (Single Enzyme Nanoparticle) [54]. Purified forms of enzymes like peroxidase can perform the synthesis of SEN. There is compounds like phenols, dyes and pesticides are decomposing by this enzymes. waste water contamination can be treated by nanotubes containing enzymes like laccases. Membrane bio reactors are also applied in waste water treatment. The mix between membrane and the enzymes for waste water treatments can be showed in the form of three processes. Immobilized enzyme membrane reactor (IEMR), Extractive membrane bioreactor (EMB). Direct contact membrane reactor (DCMR). In the process of IEMR and EMB the use of hallow fibre bioreactors increase the surface area ratio and the treatment capacity of the process [55].

Results: The application of enzymes in the treatment of pharmaceutical industrial waste water has many benefits as;

- Biological transformation of toxics in waste water.
- Enzymes are biodegradable substances.
- For using the enzymes, it is not need for high pressure or corrosions.
- It saving money and energy.
- They can use instead of contaminated chemicals.
- They are naturally coming from micro organisms.
- Modern technologies of biology nowadays helping in improve new enzymes, processes and new applied methods techniques.

Conclusions. The use of biological enzymes as laccases instead of chemical reactions in the pharmaceutical industries decrease waste chemical toxic pollutants in the environment. In waste water treatment enzymes can be used to develop remediation processes that are less hazardous than other technologies. Enzymes have an advantage over the physico-chemical treatment process. Enzymes are working on the pollutants to remove then and transfer them to less toxic materials. Use of new techniques of enzymes are leading to increase the effectiveness of treatment with less energy consume and low costs. Microorganisms make large amount of catalysts which can be used on large scales of industrial products as foods, pharmaceutics and leathers.

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