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Isolation and Characterization of an Inducible Oxidoreductase from Effluent Soil and Its Application for Textile Bio Bleaching for Environment Conservation

[1]Desai U.R, [2]Desai P.V

[1]Department of Microbiology, D.U.I.A.S, Valsad, India
[2] Department of Biosciences, V.N.S.G.U, Surat, India

Abstract: **The aim of the study was to isolate a potent microbial strain as an enzymatic source for textile biobleaching. The experiment isolated a fungal strain resembling *Aspergillus niger* from soil contaminated with textile effluents. The fungal strain exhibited decolouration of reactive dyes on solid culture media and was further analyzed in liquid state fermentation to study various production parameters. The enzyme of interest is an extracellular enzyme showing maximum decolourization at 96 hrs of fermentation cycle. The active enzyme has optimum substrate concentration of glucose at 20gm/lt and optimum pH: 5.0. The active enzyme has been identified to be an inducible Glucose Oxidase enzyme exhibiting GOX activity 3.1u/ml in the crude broth and has been partially purified using ammonium sulfate precipitation. The crude enzyme has been applied to study the biobleaching of cotton grey fabric and has shown visible bleaching effect in the experiments. The biobleaching has been validated using authentic methods at The Bombay Textile Research Association Laboratories, Bombay. The research showed that the bio-bleaching system has a powerful bleaching ability under mild process conditions and that it has the future prospect of industrial application in decreasing the environment effluent load and in water preservation.**

Keywords: **microbial enzyme, Glucose-oxidase, biobleaching, cotton.**

1. INTRODUCTION

The legacy of the Indian textile industry stemmed from its wealth in natural resources silk, cotton and jute, the technology used was superior and the skills of the weavers gave the finished product a most beautiful and ethnic look.

India is globally a significant player in the textile sector and is globally the …..

- Third largest producer of cotton and cellulose fibre/yarn.
- Second largest producer of cotton yarn.
- Largest producer of jute, second largest producer of silk.
- Fifth largest producer of synthetic fibre/yarn.

The textile sector plays a significant role in Indian economy by contributing to the gross domestic product, generating employment and earning foreign exchange.

Cotton, the ‘white gold’ is the principal raw material for a flourishing textile industry in India. Cotton textiles account for 2/3rd of India’s textile exports.

Amongst the various stages of cotton preparation wet pretreatment is a very important step in fabric processing which involves desizing, scouring and bleaching before the textile goes for dyeing or printing.

The cloth making process comprises of various steps of processing. But during these processing steps like scouring and bleaching huge amount of hazardous effluents are generated. This increases the enviournmental effluent load.

The textile dyeing consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and the finishing steps.

The various effluents generated either pollute the environment, the soil indirectly affecting the crops. Also some of the chemicals used may remain with the fabric and can cause adverse reactions in the consumers specially the children.

Chemicals that are used in the manufacture of textiles can lead to exposure of workers at the production facility and can also be emitted to the environment.

To reduce the environmental load and to reduce the hazardous emissions, it becomes necessary to explore biological tools: ENZYMES.

Bioprocessing is the application of biological organisms, systems or components to manufacturing, industrial processes and products.

It mainly relies on the application of inexpensive substrates for biosynthesis, defining and devising processes that will consume less energy, generate less effluent, will work at low temperatures and will conserve water.

The desired textile processing procedures should be those that are environment friendly and economic ones that can save water, energy, time and chemicals yet preserve product qualities.

The principal enzymes applied in textile industry are hydrolases (*amylases, cellulases, proteases, pectinases and lipases/esterases*) and oxidoreductases (*catalases*).

The prime focus for the wet processing is bleaching.

The process should be such that the residual colour is removed from the fabric without harming the texture, formation, colour or the appearance.

The waste water effluent from enzymatic treatments is readily bio-degradable and does not pose an environmental threat also the enzymatic pretreatment does not pose a risk to the health of the people associated with textile industry.

2. METHODS AND MATERIALS

To check for microbial enzyme sources isolation was done from natural sources like wastewater effluents, soils in and around the effluents or the industry and the air microflora in the high risk areas.

The possible isolates were grown in nutritional media and they were identified by dye degradation in liquid and on solid media.

The selected isolates were further tested in fermentation media to study the enzyme production and concentration.

The fermentation parameters like fermentation period, substrate concentration and pH were studied on the production of enzyme of interest.

3. RESULTS AND DISCUSSIONS

Of the different samples tested, one strain was showing potential decolourization on repeated testing.

The fungal strain shows growth resemblance to *Aspergillus sp.* The enzyme of interest was identified to be glucose oxidase by biochemical reaction.

The optimization was fermentation parameters was carried out in 250ml fermentation shake flask study incubated at $30^{O}C$ and 120 rpm for 96 hrs.

The study shows that maximum enzyme production was seen at 96hrs of fermentation cycle and optimum substrate concentration of glucose at 20gm/lt and optimum pH: 5.0.

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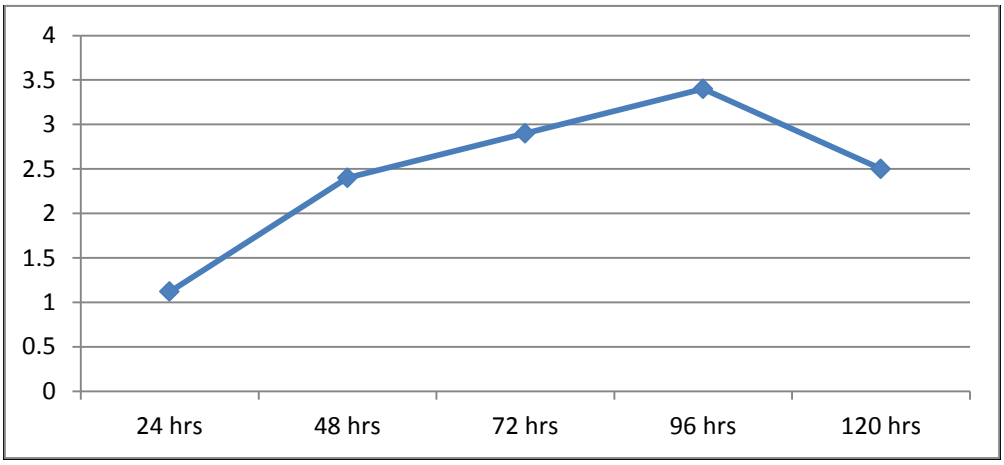

Figure 1

Figure 1 shows the effect of fermentation period on GOX production. The maximum enzyme activity was observed at 96hrs of fermentation cycle.

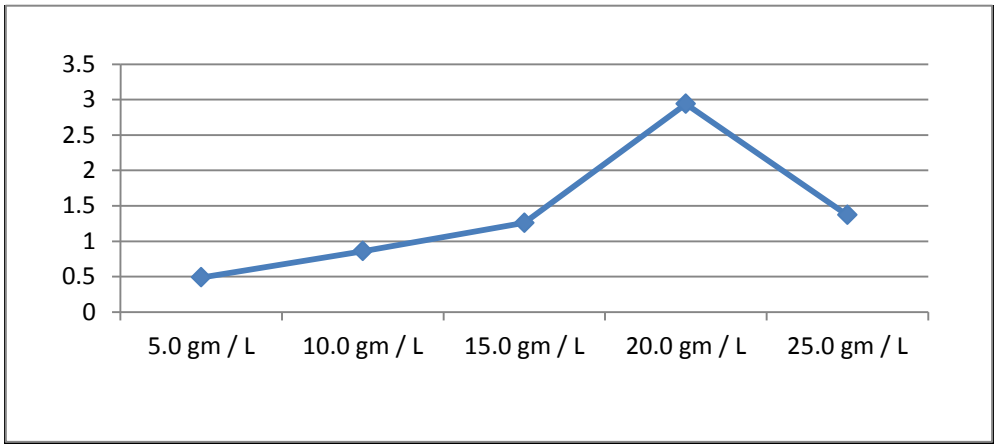

Figure 2

Figure 2 shows the effect of substrate concentration (glucose) on GOX production and the optimum substrate concentration is 20 g/L.

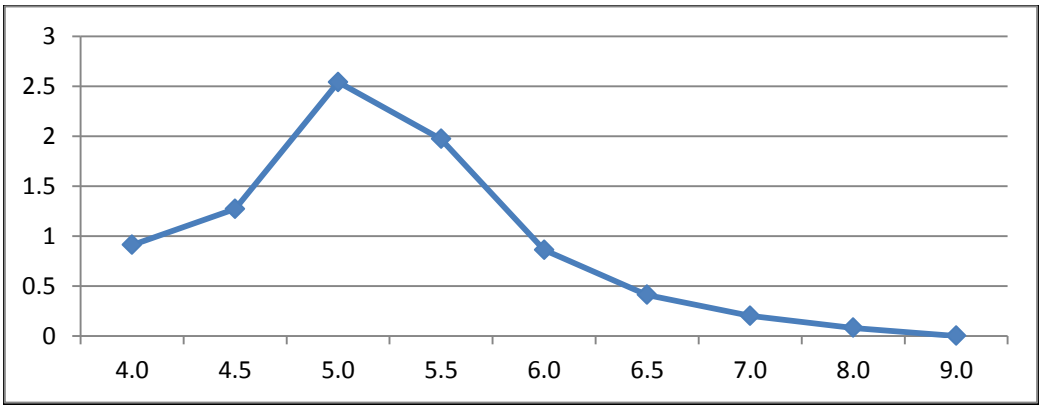

Figure 3

Figure 3 shows the effect of pH of fermentation broth on the GOX production and optimum pH was found to be pH: 5.0.

The fermented filtrate sample (96 hrs) was tested for biobleaching using greige cotton as the test material. The fabric was incubated in the filtrate at $37^{O}C$ for specified time period.

The whiteness was compared by visual methods.

The final verification for whiteness parameter was checked by testing the fabric samples in The Bombay Textile Research Association Laboratories, Bombay. The microbial crude enzymes treated fabric shows 11% increased whiteness compared to the control fabric.

4. CONCLUSION AND FUTURE TRENDS

1) The combined application system of oxidase + peroxidase can be devised as an enzymatic method for biobleaching of textiles so as to reduce the wastewaster effluent load.

2) This treatment can be optimized, adopted and applied at industrial level for the biobleaching processes, therefore decreasing the environmental load in terms of water consumption and generation of effluents.

3) The crude extract of the enzymes from the culture broths can be used directly or the purified enzyme can be immobilized and used repeatedly on large scale.

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