ROLE OF NATURAL ENZYMES AND THEIR APPLICATIONS IN TEXTILE WHITENING

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Abstract
The use of enzymes in textile industry is one of the most rapidly growing fields in industrial enzymology. The enzymes used in the textile field are amylases, catalase, and laccase which are used to removing the starch, degrading excess hydrogen peroxide, bleaching textiles and degrading lignin. The use of enzymes in the textile chemical processing is rapidly gaining globally recognition because of their non-toxic and eco-friendly characteristics with the increasingly important requirements for textile manufactures to reduce pollution in textile production. Eco friendly processes have been developed for the bleaching of fabric with a view to reduce the water consumption and processing time. There is no significant difference in the whiteness values. Further, by employing eco-friendly processes, there is significant decrease in volume of effluent generated.

Key Words: Bleaching, Eco Friendly Processing, Enzymes and its Applications.

INTRODUCTION
Enzymes were discovered in the second half of the nineteenth century, and since then have been extensively used in several industrial processes. Enzymes are generally globular proteins and like other proteins consist of long linear chains of amino acids that fold to produce a three-dimensional product. Each unique amino acid sequence produces a specific structure, which has unique properties. Enzymes are extremely efficient and highly specific biocatalysts. Commercial sources of enzymes are obtained from three primary sources, i.e., animal tissue, plants and microbes. These naturally occurring enzymes are quite often not readily available in sufficient quantities for food applications or industrial use. However, by isolating microbial strains that produce the desired enzyme and optimizing the conditions for growth, commercial quantities can be obtained.

This technique, well known for more than 3,000 years, is called "fermentation". The enzyme industry as we know it today is the result of a rapid development seen primarily over the past four decades thanks to the evolution of modern biotechnology. Enzymes found in nature have been used since ancient times in the production of food products, such as cheese, sourdough, beer, wine and vinegar, and in the manufacture of commodities such as leather, indigo and linen.

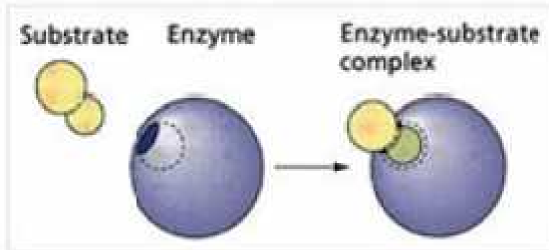
Due to constantly increasing level of pollutants Governments of many countries imposing stricter limitations on release of pollutants. Therefore there is ever increasing demand for clean processes i.e. processes which either cause no pollution or less pollution. Textile industry particularly the chemical processing sector always has a major share in the global pollution. Enzymes play key role in such alternative processes.

TEXTILE PROCESSING
Today enzymes have become an integral part of the textile processing. There are two well-established enzyme applications in the textile industry. Firstly, in the preparatory finishing area amylases are commonly used for designing process and secondly, in the finishing area. There are various applications which entail enzymes included fading of denim and non-denim, bio-scouring, bio-polishing, wool finishing, peroxide removal, decolourization of dyestuff, etc.

In the textile industry a completely new enzymatic activity has recently been introduced. This industry is under considerable environmental pressure owing to its large energy and water consumption and subsequent environmental pollution. One of the most energy- and water-consuming steps in the processing of fibre is the scouring step, the removal of various remaining cell-wall components on the cellulose fibers performed at high temperature and under strong alkaline conditions. An alternative, enzyme-based process performed at much lower temperatures and using less water has now been developed based on an enzymatic treatment.

BLEACHING
Pure white cloth is desirable not only for itself, but as the basis upon which can obtain pure colour. To obtain a white cloth, therefore, it was necessary to discover a method of destroying the colouring matters which would not at the same time injure

the fibres themselves. The bleaching step decolorizes the natural fibre pigments and removes any residual natural woody components, which are not completely removed during ginning, carding and scouring.



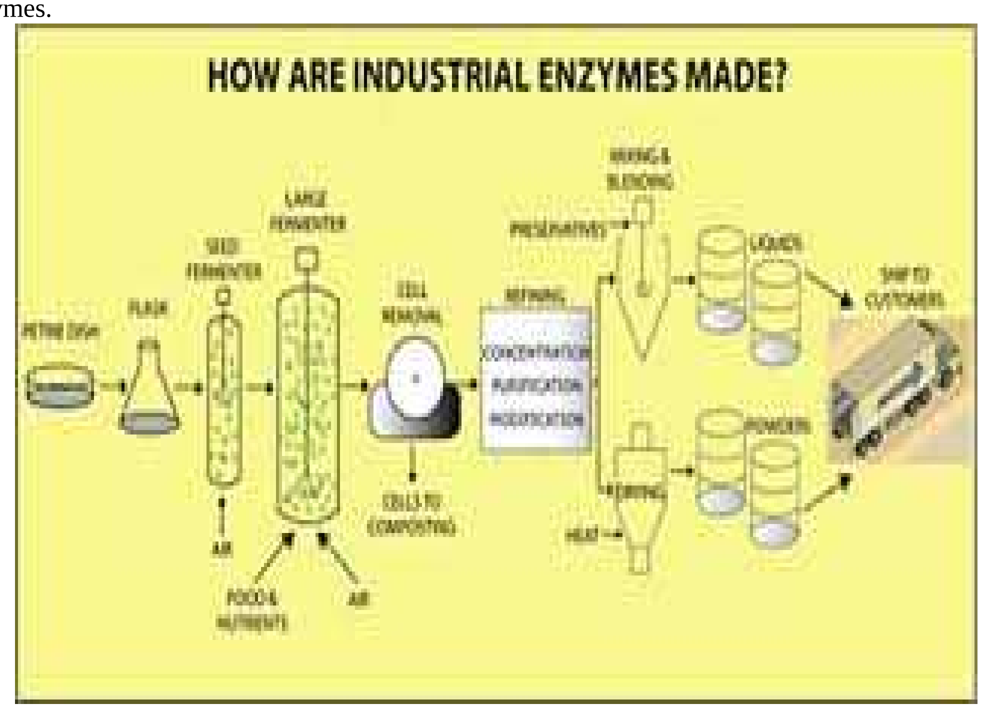
Enzymes are wonderful presents of microbial fermentation

ENZYMES

Enzymes are biocatalyst, and by their mere presence, and without being consumed in the process, enzymes can speed up chemical processes that would otherwise run very slowly. After the reaction is complete, the enzyme is released again, ready to start another reaction. Usually most enzymes are used only once and discarded after their catalytic action. Enzymes are very specific in comparison to inorganic catalysts such as acids, bases, metals and metal oxides. Enzyme can break down particular compounds. The molecule that an enzyme acts on is known as its substrate, which is converted into a product or products.

CLASSIFACATION

For each type of reaction in a cell there is a different enzyme and they are classified into six broad categories namely hydrolytic, oxidising and reducing, synthesising, transferring, lytic and isomerising. The essential characteristic of enzymes is catalytic function. Consequently, the original attempt to classify enzymes was done according to function. The International Commission on Enzymes (EC) was established in 1956 by the International Union of Biochemistry (IUB), in consultation with the International Union of Pure and Applied Chemistry (IUPAC), to put some order to the hundreds of enzymes that had been discovered by that point and establish a standardized terminology that could be used to systematically name newwly discovered enzymes.



The EC classification system is divided into six categories of basic function:

- EC1 Oxidoreductases: catalyze oxidation/reduction reactions.
- EC2 Transferases: transfer a functional group.
- EC3 Hydrolases: catalyze the hydrolysis of various bonds.
- EC4 Lyases: cleave various bonds by means other than hydrolysis and oxidation.
- EC5 Isomerases: catalyze isomerization changes within a single molecule.
- EC6 Ligases: join two molecules with covalent bonds.

Each enzyme is described by a sequence of four numbers preceded by “EC”. The first number broadly classifies the enzyme based on its mechanism.

ADVANTAGES OF ENZYME TECHNOLOGY

Enzyme technology has many distinct advantages over chemically catalyzed processes. These include:

- For many chemical reactions of commercial interest, enzymes are the only known catalysts.
- Owing to the specificity in conversion, especially in stereo specific conversion, product manufacturing is possible only with enzymes.
- Enzyme technology replaces hazardous processes and materials including chemical catalysts with eco-friendly ones.
- Enzymes can act over a wide range of concentrations. Reactions at high concentration reduce the solvent requirements and catalysis of reactions at low concentration aid high sensitivity detection, as in environmental monitoring.
- Since enzymatic conversions take place at ambient temperatures, a large amount of energy is saved.
- Enzymatic conversions result in minimal or no wasteful byproducts like solvents and toxic substances.
- Enzyme reactors can be scaled up to suit throughout requirement.

The positive environmental impact of the new process was recognized by a grant of the United States Presidential Green Chemistry Challenge Award in 2001. The use of these enzymes has benefited both the textile industry and the environment.

PROPERTIES OF ENZYMES USED IN TEXTILES

1. **Enzyme accelerates the reaction**

   An enzyme accelerates the rate of particular reaction by lowering the activation energy of reaction. The enzyme remains intact at the end of reaction by acting as catalyst.
2. **Enzymes operate under milder condition**

   Each enzyme have optimum temperature and optimum pH i.e. activity of enzyme at that pH and temperature is on the peak. For most of the enzyme activity degrades on the both sides of optimum condition.
3. **Alternative for polluting chemicals**

   Enzymes can be used as best alternative to toxic, hazardous, pollution making chemicals. Also some pollutant chemicals are even carcinogenic. When we use enzymes there is no pollution.
4. **Enzyme acts only on specific substrate**

   Most enzymes have high degree of specificity and will catalyse the reaction with one or few substrates. One particular enzyme will only catalyse a specific type of reaction. Enzymes used in desizing do not affect cellulose hence there is no loss of strength of cotton.
5. **Enzyme are easy to control**

   Enzymes are easy to control because their activity depends upon optimum condition.
6. **Enzymes are biodegradable**

   At the end of reaction in which enzymes used us can simply drain the remaining solution because enzymes are biodegradable and do not produce toxic waste on degradation hence there is no pollution.

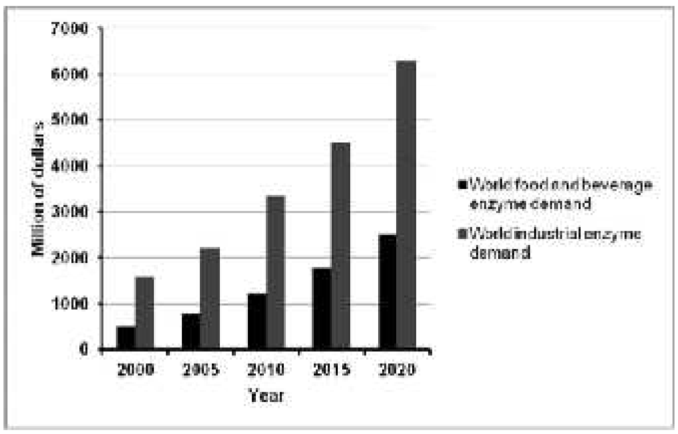
ENZYME APPLICATIONS IN TEXTILE PREPARATORY PROCESS

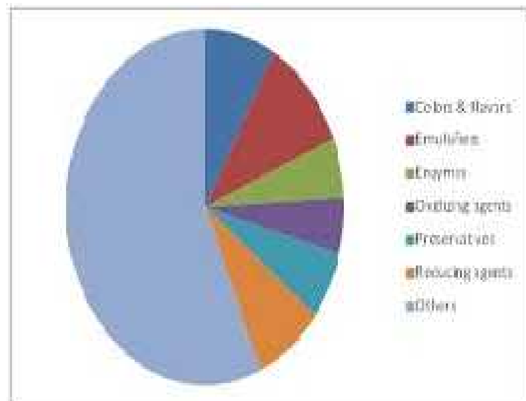
ENZYMATIC DESIZING

For fabrics made from cotton or blends, the warp threads are coated with an adhesive substance known as ‘size’ to lubricate and protect the yarn from abrasion preventing the threads to break during weaving. Although many different compounds have been used to size fabrics, starch and its derivatives are the most common because of their excellent film forming capacity, availability and relatively low cost. The starch is randomly cleaved into water soluble dextrins that can be then removed by washing. This also reduced the discharge of waste chemicals to the environment and improved working conditions.

ENZYMATIC SCOURING

Greige or untreated cotton contains various non-cellulosic impurities, such as waxes, pectins, hemicelluloses and mineral salts, present in the cuticle and primary cell wall of the fibre. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of enzymatic scouring process are 20-45 % as compared to alkaline scouring (100 %). Total Dissolved Solid (TDS) of enzymatic scouring process is 20-50% as compared to alkaline scouring (100%). Handle is very soft in enzymatic scouring compared to harsh feel in alkaline scouring process. Enzymatic scouring makes it possible to effectively scour fabric without negatively affecting the fabric or the environment. It also minimizes health risks hence operators are not exposed to aggressive chemicals.





ENZYMATIC BLEACHING

The purpose of cotton bleaching is to decolorize natural pigments and to confer a pure White appearance to the fibres. Mainly flavonoids are responsible for the colour of cotton. The most common industrial bleaching agent is hydrogen peroxide.

Conventional preparation of cotton requires high amounts of alkaline chemicals and consequently, huge quantities of rinse water are generated. However, radical reactions of bleaching agents with the fibre can lead to a decrease in the degree of polymerization and, thus, to severe damage. Therefore, replacement of hydrogen peroxide by an enzymatic bleaching system would not only lead to better product quality due to less fibre damage but also to substantial savings on washing water needed for the removal of hydrogen peroxide.

An alternative to this process is to use a combination of suitable enzyme systems. Amyloglucosidases, pectinases, and glucose oxidases are selected that are compatible concerning their active pH and temperature range. The enhancement of the bleaching effect achieved on cotton fabrics using laccases in low concentrations. In addition, the short time of the enzymatic pre-treatment sufficient to enhance fabric whiteness makes this bio-process suitable for continuous operations. A laccase from a newly isolated strain of *T. hirsuta* was responsible for whiteness improvement of cotton most likely due to oxidation of flavonoids. A combined ultrasound-laccase treatment for cotton bleaching is used. They found that the supply of low ultrasound energy (7W) enhanced the bleaching efficiency of laccases on cotton fabrics. Natural fabrics such as cotton are normally bleached with hydrogen peroxide before dying. Catalase enzyme is used to break down hydrogen peroxide bleaching liquor into water molecules and less reactive gaseous oxygen. Compared with the traditional clean-up methods, the enzymatic process results in cleaner waste water or reduced water consumption, a reduction of energy and time.

ADVANTAGES OF ENZYMES IN TEXTILE PROCESSING

1. They are of natural origin and are nontoxic.
2. They have great specificity of action; hence can bring about reactions not otherwise easily carried out.

IJMSRR
E- ISSN - 2349-6746
ISSN -2349-6738

3. They work best under mild conditions of moderate temperature and near neutral pH, thus not requiring drastic conditions of high temperature, high pressure, high acidity, and the like, which necessitate special expensive equipment.
4. They act rapidly at relatively low concentrations, and the rate of reaction can be readily controlled by adjusting temperature, pH, and amount of enzyme employed.
5. They are easily inactivated when reaction has gone as far as desired.
   Because of these inherent advantages, many industries are keenly interested in adapting enzymatic methods to the requirements of their processes.

CONCLUSION

These are just a few applications of enzymes, however much such potential are yet to be explored. Biotechnology finds wide application in textiles and it will prove to be a boon to the ever-changing conditions of the ecology as well as economy. As with all chemicals and products, enzymes too have their own merits and limitations. They show specific action without undesirable effects on other components and normally operate under mild temperature and pressure conditions, but at the same time are sensitive to temperature, pH, humidity and contaminants. Enzymes can be used in order to develop environmentally friendly alternatives to chemical processes in almost all steps of textile fibre processing.

There are already some commercially successful applications. Enzymes are emerging in a big way in the field of textile wet processing. If their cost can be managed, enzymes can be put to use in a much bigger way for textile processing applications. There is still considerable potential for new and improved enzyme applications in future textile processing. Industrial uses of enzymes have increased greatly during the past few years. Prospects are excellent for continuing increased usage of presently available enzymes in present applications, and in new uses, and of new enzymes for many purposes.

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