An Overview on Microbial Enzymes and their Industrial Applications

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ABSTRACT

The application of enzymes for commercial interests is a very well-known practice over centuries. A diverse range of new enzymes have been discovered with the progression of technologies and some of these are yet unexplored. The environment-friendly nature of microbial enzymes gained interest of researchers becausethey reduce the production of greenhouse gases, during industrial processing. There are so many applications for microbial enzymes in a variety of industries for example (textiles, leather, paper and pulp, pharmaceutical, agriculture, detergent, waste, biorefineries, photography and food industries. There is a preference for microbial enzymes over plants and animals' sources because of some of their specific characteristics e.g.- inexpensive production value, short time taken procedure and high yield. This review focuses on to reveal some industrial enzymes listed in comprehensive manner with their microbial origins and a diverse range of commercial implementation.

Keywords: biorefineries, greenhouse gases, industrial enzymes, lipase, microbes, pectinase, pharmaceuticals.

Introduction:

Enzymes are the potential catalysts in biological processes which have been gained attention by researchers worldwide, over the years because of their diverse number of applicability in commercial industries. Though several sources are present from which enzymes can be extracted, purified, for example, microbial sources, plant sources, animal sources, but microorganisms are found to be very useful source for enzyme production because of their wide range of diversity in biochemical structure, easy manipulation of their genetic structure and possibility in huge culture range. These are the reasons of microorganism of being primary source of enzymes as they can be cultured and produced in a huge amount and that is also in a comparatively smaller time duration (Anbu et al., 2017).

This is being practiced for a pretty ancient period of time of the production of enzymes for industrial uses and specially produced from microorganisms and also from plant sources as well. (Underkofler et al., 1958) One well known practice that can be stated here is that yeast has been used for a long time for the production of wine, beer, bread, cider among others through a procedure known as fermentation. This is an example of application of the microbial enzyme in industrial interest (Arevalo-Villena et al., 2017).

The enzymes isolated and extracted from microbial sources, have a greater part to play, compared to animal and plant-based enzymes, because of their stability. Another important reason for choosing microbial enzymes for food industrial application because they can be produced easily in huge amounts in very inexpensive manner of fermentation (Raveendran et al., 2018).

For these aforementioned qualities of microbial enzymes i.e., less expensive with high quantity of output in a lesser period of time, these have gained a global acceptance in a diverse range of sectors vis-à-vis, pharmaceutical industry, food technology, textiles, detergents, cosmetics, agriculture and many more. (Singh et al., 2016)

This review summaries an overview of industrially important enzymes along with their sources and commercial applications.

Pectinase:

Pectinases are a group of enzymes which can break down the Pectic Substances or Pectin. The extraordinarily complex bio-macromolecules found in nature is pectin which comprises different mono and polysaccharides (Haile and Ayele, 2022). This group of enzymes can be classified according to their mode of actions, for example, methyl groups are being removed by methyl Esterases. In view of industrial applications, the utilization of a combination of these multiple classes of pectinases should be instructed, along with cellulases and hemicelluloses. In order to degrade all sections of a polymer, various enzymes namely, different classes of pectinases, cellulase and hemicelluloses are essential for optimal levels of degradation. This technique can be commonly employed in Fruit Juice processing Industries (KC et al., 2020). The common microbial sources of industrially viable pectinases, are, fungi specially Aspergillus niger, which contributes in production of acidic pectinases and bacteria, Bacillus sp., from which alkaline pectinases can be yielded. Pectinases have a multidisciplinary applicability in industrial applications. For example, in beverage making companies extraction of fruit pulp in order to generate and process clarified fruit juices, there has been an extensive use of pectinase enzyme (Shet et al., 2018) Acidic pectinases is also being used in Wine processing industries. In order to speed up the clarity and filtration rate during wine processing the fermented pectinase is given into it. On the other hand, in industries like, paper-pulp industries, textile industries Alkaline pectinases have a great demand. (Oumer, 2017).

Alpha-Amylase:

Another important and industrially viable enzyme is alpha-amylase. This enzyme is also being extracted from the microbial source e.g., Yeast, bacteria and fungi, and in commercial utilisations this microbial enzyme has a great impact. In view of

alpha-amylase production quantity, it has been studies that, the productivity depends on the genus, species and strain of that particular microorganism. There are three classified types of microbial enzymes, namely- alpha, beta and gama subtypes. (Gopinath et al., 2017) Some organisms widely studied as the source of microbial alpha-amylase productions are as follows, Nesterenkonia sp., Pseudoalteromonas sp. Aspergillus niger, Aspergillus awamori and Aspergillus oryzae (Far et al., 2020). A numerous commercial and industrial utilization of microbial alpha-amylase enzyme has been noted and listed. Their use is budding in different industrial purposes such as starch processing industries, detergent industries, paper and pulp industries, textile and garment industries etc. Drugs and pharmaceutical industries have also a rising demand for utilization of microbial alpha-amylase in novel areas of applications, like therapeutic use of cancer treatment (Sindhu et al., 2017).

Protease:

The group of proteolytic enzymes, proteases, has a great contribution in industrial applications, which can be found in microbial sources, is very much abundant in nature. Protease enzyme can be easily found everywhere in nature, for example in plants, animals, microorganisms etc. In protein molecule, the amino acids are connected or bound together by peptide bond formation, which is found in polypeptide chain. The protease enzyme hydrolyses the peptide bonds between two amino acids and breaks down the protein molecule. That's why this enzyme is called degradative enzyme. One of the common active extracellular protease sources for industrial purpose is Bacillus sp. (Razzaq et al., 2019). A wide range of microbial sources are identified for extraction of proteases, those are genus Pseudoalteromonas, Psychrobacter Photobacterium, Vibrio, Halobacillus, Bacillus, Microbulbifer, and Shewanella. Industrial implementation of the uses of protease enzyme is diverse. For examples, utilization of proteolytic enzyme protease can be found in leather processing industries, meat tenderization, cheese preparation, fortification of fruit juices, baking and bakery, detergent industries and in pharmaceuticals. (Bannerjee and Ray, 2017).

Lipase:

The lipolytic enzyme Lipase found from microbial sources is plentiful in environment and commercially important in various manufacturing units. This enzyme is the descendent of triacylglycerol ester hydrolase groups which speed up the hydrolysis reaction of long chain triglyceride to short chain fatty acids (Chandra et al., 2020). Microbial lipases have received optimal recognition from several industries, over other potential sources, because of some special characteristics, such as their steadiness, differentiation quality and broad substrate precision (Bharathi and Rajalakshmi, 2019). The hugely studied microbial lipase producing microorganisms are Bacillus, Pseudomonas, Serratia, Penicillium, Candida, Aspergillus etc. Bakery industry one of the prime industries where lipases are being used, for enhancing the sensory properties e.g., Taste and flavour of bakery products (Priji et al., 2021). Other industrial contributions of lipase enzymes are counted in detergent production, where use of surfactants' quantity has been

reduced remarkably and replaced by the utilization of lipase. In paper and pulp manufacturing units' lipases are being used in pitch removal process, known as despatching (Agobo et al., 2017).

Cellulase:

From microbial origin another huge group of enzymes are cellulolytic, acts upon cellulose and hydrolyses cellulosic polymers, known as Cellulase. The prime function of Cellulase enzyme is cellulose hydrolysis, and this function of the enzyme is studies over the years and utilized in diverse range of industrial applications (Jayasekara and Ratnaayake, 2019). There is a versatile applicability of microbial cellulase enzymes in different commercial industries e.g., fruit juice extraction, producing food colouring substances, alteration and enhancement of odor, flavor, tastes of fruits and vegetables. Apart from food industries the hydrolysis property of cellulase enzyme is being taken up by beer and wine industries for improvement of aroma of wine. Also, this enzyme is being used in agriculture industries for soil fertilization (Behera et al., 2017).

Lactase:

Lactase enzyme, which is also known as beta-galactosidase, can be obtained from a numerous source of nature,

e.g. Plants, archae, plants, animals. Among these microbial sources are well preferred because of its cheaper production cost and easy availability in environment. The beta-galactosidase is mostly used in diary industrial processing. For examples, in order to improve digestibility of the dairy products, lactase enzyme is being added with milk or milk-based manufacturing products (Liu and Kokare, 2023). The microbial origins, well studies for extraction of beta galactosidase are Aspergillus niger, Aspergillus oryzae, Kluyveromyces lactis and Kluyveromyces fragilis, Escherichia coli, Klebsiella and Bifidobacterium longum. (Okpara, 2022).

Catalase:

The most popular oxidoreductase enzyme from microbial sources is, Catalases, a group of enzymes which takes part in reduction of hydrogen peroxide into oxygen and water. This enzyme regulates the metabolic activities of hydrogen peroxide. This enzyme possess antibiotic property hence provides protections to cells against any kind of stress originated from oxidation (Kaushal et al., 2018). Microbial sources of catalases are in demand for industrial purposes because of their less difficulty in handling and genetic structural manipulations also can be done to obtain the product with desired traits. Aspergillus niger, the fungi, have gained attention as the source of industrial catalase enzyme production. Potential microbial sources, which has been studied as catalase producers isolated from different industrial by-products, environment, hot springs etc., are listed down. Those are, Pyrobaculum calidifontis Enterococcus faecalis, Bacillus maroccanus, Bacillus halodurans, Oceanobacillus oncorhynchi ssp., Rhizobium radiobacter, Serratia (Patel et al., 2023). In view of industrial applications, catalase is being used in diverse spectrum. Diary industry is one of the important sectors of catalase utilization, to reduce and eliminate the substance peroxide from raw milk. Since catalase in oxidoreductase enzyme, catalase in also used for in textile industries for the elimination of excess quantity of hydrogen peroxide added to

subjected fabric. Wine industry is also being contributed by microbial catalases in reduction or elimination of oxygen from wine while the wine is pouring in bottles during packaging (Milek et al., 2014).

Xylanase:

Microbial xylanase is another commercially important enzyme, which acts upon hemicellulose or xylans compound and helps in hydrolysis of its substrate, named Xylane which possess heterogenous traits. This heterogenous hemicellulose undergoes hydrolysis in presence of xylanolytic enzymes e.g., endoxylanase, β- xylosidase, α-glucuronidase. These are the group of xylanolytic enzymes. These enzymes have been isolated from a different source, among which microbial sources are potent for industrial purposes. Bacillus sp., Streptomyces sp., Pseudonomas sp., Clostridium sp are some of the xylanases producing microbial sources (Burlacu et al., 2016). The potential implementation of xylanase enzymes can be noted down as follows. Microbes are the cost-effective source of xylanolytic enzymes production which are directly connected in use at paper and pulp industries for hydrolysis of xylan in order to produce monomers from hemicellulose polymer. Apart from this microbial xylanase is also popularly being applied in food industries, beverages production, agro-waste managements and many more (Subhramaniyam and Prema, 2002).

CONCLUSIONS

The most abundantly found biological catalyst in nature and environment is enzyme, which speed up any bio and chemical reactions. They are isolated from a diverse range of sources but among other potential enzyme sources, microbial enzymes are getting their rising demands and increasing in commercial utilization. Their stability, selectivity of substrates, cheaper production cost seeks the interest od industrial manufacturer in diverse fields of productions. Paper and pulp industries, detergent industries, beverages production units, fabric production units, textiles, animal feeds are the budding fields for effective uses of enzymes. In view of producing the particular enzymes for commercial interests, several studies have shown, solid state fermentation and sub-merged fermentation are the successful approaches for yielding necessary enzymes. Studies are till going on for exploring beneficial enzymes from novel microbial origins for commercial interests, which are till unexplored. The novel applications of microbial enzymes are also the concerned area of researchers till today.

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Conflict of Interest. None

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