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Applications And Future Perspectives Of Xylanase Enzyme: A Review

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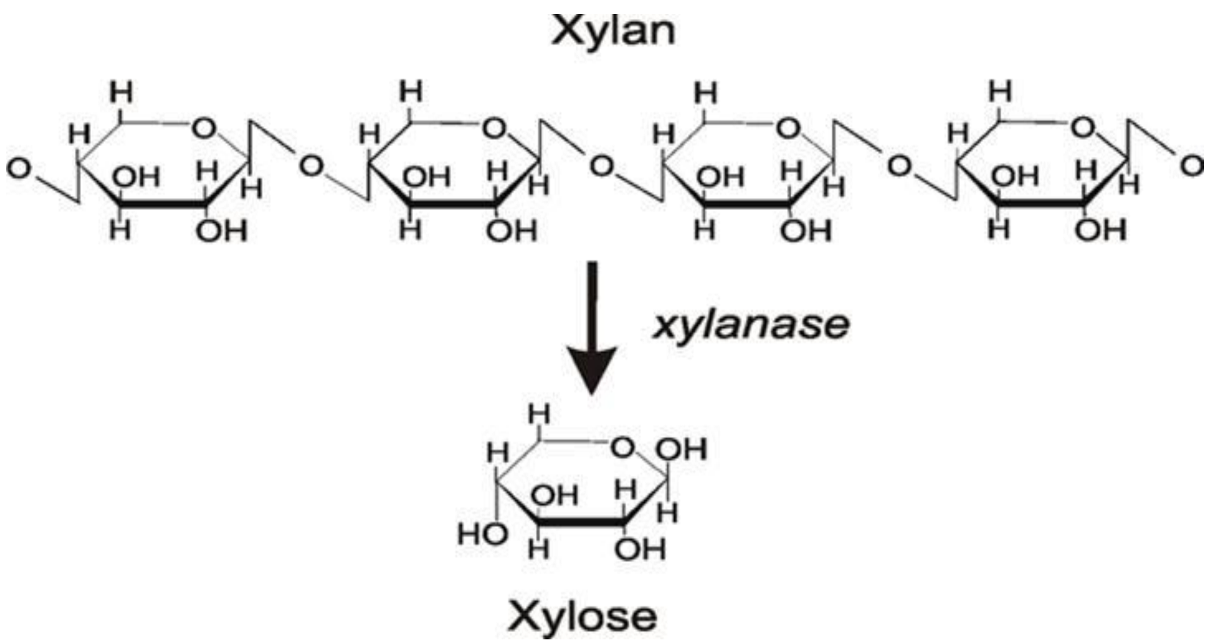
Abstract

Xylanase (EC 3.2.1.8, Endo-(1-4)-β-Zeelan-4-xylanohydrolase, Endo-1,4-Zelanase, Endo-1,4-β-Zelanase, -1,4-Zelanase, Endo- 1,4-β-D-xylanase and 1,4-β-xylanxylanase (β-xylanase, β-1,4-xylanxylanase, β-D-xylanase) belong to beta group 14, whose name is converted to xylose. Hemicellulose is the main components of the cell wall, which plays an important role in microbes that break down plant material from plant sources ..Xylan is used in fungi, bacteria, yeast, algae, protozoa, cattle, crustaceans, insects, seeds, etc. (Mammals do not produce xylanase). It is also used as a fermented fertilizer. Xylase is used in the pulp and paper industry, poultry feed additive, flour processing, flour, coffee, vegetable oil and starch extraction to improve the quality of baked goods and improve the nutritional properties of food and feed. Sources of plant fibers such as flax and hemp, jute and lamb, including pectinase and cellulase, are used to refine fruit juices and extract oils, and are used in conjunction with them.

Xylanase (EC 3.2.1.8, endo-(1-4)- β-xylan 4-xylanohydrolase, endo-1,4-xylanase, endo-1,4-β-xylanase, β-1,4-xylanase, endo-1,4-β-D-xylanase, 1,4-β-xylan xylanohydrolase, β-xylanase, β-1,4-xylan xylanohydrolase, β-D-xylanase) is that the name given to a class of proteins which debase the straight polysaccharide beta-1,4-xylan into xylose, consequently separating hemicellulose, one among the principle segments of plant cell dividers. It assumes a genuine part in miniature life forms blossoming with plant hotspots for the debasement of plant matter into usable supplements. Xylanases are delivered by organisms, microbes, yeast, marine green growth, protozoans, snails, scavengers, creepy crawly, seeds, and so forth (vertebrates don't create xylanases). Business applications for xylanase incorporate the sans chlorine fading of mash before the papermaking system, and consequently the expanded edibility of silage (in this viewpoint, it's likewise utilized for fermentative treating the soil). Xylanase use inside the mash and paper industry, food added substances to poultry, in flour for further developing mixture taking care of and nature of prepared items, for the extraction of espresso, plant oils, and starch, inside the improvement of healthful properties of agrarian silage and grain feed, and along with pectinase and cellulase for explanation of organic product juices and degumming of plant fiber sources like flax, hemp, jute, and ramie.

Introduction

Compounds are the synergist specialists of digestion and naturally are the fundamental objective of extreme overall examination, inside the organic local area, yet in addition with measure architects, synthetic designers and analysts working in other logical fields (Dhulappa and Lingappa, 2014). Proteins are the always present miracles of the organic world, catalyzing one substance into a fabric that is considerably unique. Nonetheless, proteins are delicate and work inside quite certain temperature and pH that mirror their cell beginning (Mahmoud and Helmy, 2009). Since past, catalysts play had a focal impact in many assembling measures, as inside the creation of wine, cheddar, bread, change of starch and so forth (Schauer and Borriss, 2004). Utilization of catalysts in cleanser, calfskin and paper ventures requests ID of exceptionally stable proteins dynamic at outrageous pH and temperature. The search for extremophilic creatures is one among the means for acquiring chemicals with properties reasonable for mechanical applications.



Chemical structure of xylan and xylose enzyme

Substance construction of xylan and xylose catalyst Xylanase proteins discover broad use in different enterprises like synthetics, fuel, food, brewery and wine, creature feed, material and clothing, mash and paper, and horticulture. Xylanase microorganisms are widespread in nature and might be disconnected from plant deposits like agrarian side-effects (Wei *et al* ., 2009), or from warm spring conditions where natural carbon is out there (Marques *et al* ., 1998; Mawadza *et al* ., 2000). Individuals from the bacterial genera Anoxybacillus and Bacillus are displayed to discharge a spread of cellulases (Ibrahim and Diwany, 2007; Pakpitcharoen *et al* ., 2008) and xylanases (Nagar *et al* ., 2010; Kambourova *et al* ., 2007; Duarte *et al* ., 2000; Weinstein and Albersheim, 1979).

Xylan hydrolyzing compound:

The substrate of xylanase, xylan, is that the second most-bountiful polysaccharide in nature, representing around 33% of the sustainable natural carbon on Earth (Collins *et al* ., 2005) and it comprises the fundamental part of hemicellulose, a rich of polymeric carbs, including xylan, xyloglucan, glucomannan, galactoglucomannan and arabinogalactan (Shallom and Shoham, 2003). The capacity cell divider harbors the vast majority of the xylan present in plant cell. The xylan bounty away cell dividers shifts between 20% (for hardwoods and herbaceous plants) to half (for grasses and cereals) (Ebringerova *et al* ., 2005).

Xylanases, a gaggle of hydrolytic compounds, catalyze the hydrolysis of xylan which are hereditarily single chain glycoproteins, 6–80 kDa, dynamic between 40 to 60˚C (Butt *et al* .,2008). The whole enzymatic hydrolysis of xylan into its constituent monosaccharides requires the synergistic activity of a consortium of xylanolytic proteins. this is frequently on account of the very reality that xylans from various sources show a major variety in piece and design (Latif *et al* .,2006). Xylanases are viewed as prepared to viably hydrolyze xylan, the essential kind of hemicellulose containing a direct polymer of β-Dxylopyranosyl units connected by (1-4) glycoside bonds. Microbial proteins act helpfully to change over xylan to its constituent basic sugars. These chemicals incorporate β-1,4-endoxylanases (xylanases EC 3.2.1.8), separate interior glycosidic securities inside the xylan spine; arabinofuranosidase (EC 3.2.1.55), hydrolyzes arabinose side chains; R-glucuronidase (EC 3.2.1.131), eliminates glucuronic corrosive side chains from xylose units; xylan esterases (EC 3.1.1.6), discharge acetic acid derivation gatherings and at last xylosidase (EC 3.2.1.37), hydrolyzes xylobiose to xylose. there's a significant level of cooperative energy among these proteins. Numerous xylanases don't separate glycosidic connections between xylose units that are subbed. Accordingly, side chains should be cut before the xylan spine is completely hydrolyzed. On the other hand, a few frill catalysts will just eliminate side chains from xylooligosaccharides and accordingly require xylanases to somewhat hydrolyze the plant primary polysaccharide, before side chains are regularly severed. These proteins are possibly usefull inside the biodegradation of lignocellulosic biomass to powers and synthetic compounds, in further developing rumen absorption and to be utilized inside the prebleaching of kraft mash, chiefly because of a craving to move away the use of chlorine as a detergent (Al-Bari *et al* .,2007). Xylans don't shape firmly stuffed designs and are effectively available to hydrolytic catalysts. Therefore, the exact movement of xylanase is 2 to multiple times more prominent than the hydrolases of different polymers like translucent cellulose. inside the pulping system, the resultant mash includes a trademark earthy colored tone because of the presence of remaining lignin and its subordinates. The power of mash tone might be a component of the amount and substance condition of outstanding lignin. to get white and splendid mash reasonable for assembling great quality papers, it's important to dye the mash to dispose of the constituents like lignin and its corruption items. Biobleaching of mash is accounted for to be easier with xylanases than with lignin corrupting compounds. this is frequently in light of the fact that lignin is crosslinked generally to the hemicellulose which is more promptly depolymerised than lignin.

Scientific categorization of xylanases

The heterogeneity and intricacy of xylan has brought about wealth of assorted xylanases with differing specificities, essential successions and folds, consequently prompted limits with characterization of those compounds by substrate explicitness alone. Wong *et al* . (1988) ordered xylanases into two gatherings on the possibility of their physicochemical properties: (I) having low sub-atomic mass (30 kDa) and acidic pI. Be that as it may, numerous xylanases, particularly contagious xylanases, can't be ordered by this procedure . A more complete course of action has been presented which permits the characterization of xylanases, yet additionally of glycosidases by and large . this method has now become the quality means for the grouping of those compounds and is predicated on essential construction correlation of the reactant areas just and arranges the proteins in groups of related successions (Henrissat and Coutinho 2001). The underlying order gathered cellulases and xylanases into 6 families (A–F), which was refreshed to 77 families in 1999 (1–77) and still keeps on developing as new glycosidase groupings are being distinguished. Proteins inside a particular family have comparative three-dimensional design and atomic instrument and it's likewise been recommended that they'll have an indistinguishable explicitness of activity on little, solvent, manufactured substrates (Henrissat and Coutinho 2001). As of now, 14 unique tribes are proposed (GH-A to GH-N), most groups are made out of two to 3 families, beside faction GH-A which right now includes 17 families. Inside this game plan , xylanases are typically announced as being bound to families 10 and 11 which were once alluded to as class F and G respetively (Collins *et al* . 2005). Characterizations upheld relative sub-atomic mass and pI are fundamentally connected with those upheld succession and arrangement investigation can dependably anticipate precious stone construction, yet couple of studies are played out that relate grouping or underlying family to activity examples and substrate explicitness. Considerably less examinations have investigated the explicitness of hemicellulases concerning stretching examples or replacement. Family 10 xylanases incidentally show endocellulase movement; they ordinarily have a superior relative sub-atomic mass , and that they once in a while will have a cellulose restricting area. though all xylanases are endo acting, they will show varieties in their item profiles. A few chemicals structure prevalently xylose and xylobiose *et al* . dominatingly (or solely) structure xylotriose and other higher oligosaccharide items. This distinction seems to result from the measure of substrate-restricting subsites on the catalyst surface. the measure of pyranose rings that the catalyst will tie successfully decides the personality of the oligoproducts. The family 10 synergist space might be a round and hollow [α]-barrel looking like a plate of mixed greens bowl with the reactant site at the smaller end, close to the C-end of the [β]-barrel. There are five xylopyranose restricting destinations. Reactant areas of those proteins have a place with a "super family" that has Family A cellulases, [β]-glucosidase, [β]-galactosidase, [β]-(1-3)-glucanases and [β]-(1-3, 1-4)- glucanases. Family 10 xylanases have moderately high sub-atomic loads, and that they will in general make oligosaccharides.

Microbial sources of xylanase

Many microorganisms, including fungi and bacteria, produce 1,4-β-D-endoxylanases and β-xylosidases (Kulkarni *et al* ., 1999; Subramaniyan and Prema, 2002). Microbial xylanases are divided into two groups according to their physical and chemical properties, such as molecular weight and photoelectric spots (Wong *et al* ., 1988). The main group consists of high molecular weight xylanases with low pI values and the second group consists of relatively low molecular weight xylanases with high pI values (Kuno *et al* ., 2000).

Bacterial Xylanse

With a few exceptions, bacterial xylanase produces more xylanase than most fungal enzymes. Bacillus subtilis Organelle produces high xylanic acid activity at alkaline pH and high temperature. (Subramaniyan and Prima 2000; Subramaniyan *et al* ., 2001). Streptococcus Several types of filamentous fungi, including: , NS. injection, S. Cuspidosporus is also a potent producer of indoxylanase, xylanase, and polygalacturonic (Maheshwari and Chandra, 2000). Caldocellum saccharoticum sp. Anaerobic heat resistance. Used in the production of xylanase and endoxylanase.

Fungal Xylanse

Fungal xylanase has been involved in many organisms over the years, including the genus Penicillium. (Fadell and Fauda, 1993; Gaspar *et al* ., 1997), Trichoderma reesi (Liu *et al* ., 1999), Aspergillus nidulans (Pinaga *et al* ., 1994; Ganga *et al* ., 1998), Aspergillus (Kawachi *et al* ., 1998). Streptomyces (Patel *et al* ., 1994; Kansoh and Gammel, 2001) were created for xylanase biosynthesis. However, Aspergillus niger has been described as the most potent organism in xylanase biosynthesis (Wang *et al* ., 1998; Chen *et al* ., 1999; Wu *et al* ., 2000; Haq *et al* ., 2002).

Thermophilic xylanase

Many thermophilic (optimal growth at 50–80 ° C) and thermophilic (optimal growth> 80 ° C) microorganisms are organic organisms that degrade along with terrestrial and marine saltfields, hot springs and heated pools. contain substances. ... Spontaneously heated waste (Vieille and Zeikus 2001; Dean and Anderson, 1991; Sunna and Bergquist, 2003). The xylanase 10 family has been isolated from various thermophilic and hyperthermic organisms, but the thermophilic xylanase 11 family has not been studied very often. inspiratory temperature. Family of 10 xylanases. The FjSS3-B.1 strain is one of the most thermostable xylanases ever measured, with an optimum temperature of 105 ° C and a half-life of 90 minutes. at 95 ° C (Simpson *et al* ., 1991). Xylanase Nonomuraea flexuosa and Dictyoglomus thermophilum showed an optimum temperature of 80 ° C. It is one of the most stable at 85 ° C. Various strains of Thermococcus zilligii (Cady *et al* ., 2001), Pyrococcus furiosus (Cady *et* *al* ., 2001), Sulfolobus solfataricus (Cannio *et al* ., 2004), Pyrodictium abyssi (Andrade *et al* ., 1999) and Thermophylum (Andrade *et al* . , 1999).

Xylanase Production

Xylanase can be produced using solid culture systems and immersion culture methods. Most researchers use immersion culture to control ventilation rate, pH and temperature, and various environmental factors required for optimal microbial growth. However, in recent years, solid fermentation has again attracted the interest of researchers and is widely used for the production of xylanase (Haltrich *et al* ., 1996). This is associated with many technical and economic benefits (Pandey *et al* ., 1999). Due to their heat-resistant alkalinity, bacteria are widespread in scientific research and industry. Typically, the optimum pH for bacteria is higher than that for fungi, making it suitable for use in the pulp industry. Bacillus polymyxa produces two β-arabinofuranosidase polypeptides. Rhodothermus marinus is a strong thermophilic bacterium that produces β-arabinofuranosidase. There are several microorganisms that are optimally active at high temperatures. Geobacillus thermoleovorans (Verma and Satyanarayan, 2012), Streptomycesp. S27 (Li *et al* ., 2009), Bacillus firmus (Chang *et al* ., 2004), Actinomaduasp. Strains Cpt20 (Taibi *et al* ., 2012) and Saccharopolyspora pathunthaniensis (Sinma *et al* ., 2011) were active at temperatures of 65-90 ° C. Bacillus has a high potential for producing xylanase enzymes (Kulkarni, 1999; Qinnghe *et al* ., 2004; Wubah *et al* ., 1993; Matte *et al* ., 1992 and 1993).

Advantages of bacterial xylanase over fungal xylanase

In addition to xylanase, fungi produce several coenzymes necessary for the degradation of substituted xylan (Polizeli *et al* ., 2005). White rot bacteria produce extracellular xylanase, which acts on various hemicellulose substances that serve as food sources (Buswell *et al* ., 1994) and metabolites of interest to the pharmaceutical, cosmetic and food industries. R., 2004). Basidiomycetes usually secrete large amounts of this enzyme to break down lignocellulosic substances. For example, Phanerochaete chrysosporium produces high levels of β-glucuronidase (Castanares *et al* ., 1995), and Coriolus versicolor produces a combination of xylanolyte enzyme complexes (Abd El-Nasser *et al* ., 1997). Xylanase is also produced by Cuninghamella subvermispora when grown on plant cell wall polysaccharides or wood chips (de Souza-Cruz *et al* ., 2004). Fungal xylanase is usually associated with cellulose (Steiner *et al* ., 1987). Cellulose is contained in cellulose matrices that produce cellulases and xylanases

(Gilbert *et al* ., 1998), and these strains can be traced back to hemicellulose. However, the selective production of xylanase is only possible with xylan as a carbon source. The mechanism for controlling the formation of extracellular enzymes in carbon sources in the environment is influenced by the availability of precursors for protein synthesis. Xylanase has been reported in the genera Bacillus, Streptomyces and other bacteria that do not play a role in phytopathogenicity (Esteban *et al* ., 1982). The highly thermophilic Rhodother musmarinus has been reported to produce β-L-arabinofuranosidase (Gomes *et al* ., 2000), and two other polypeptides with β-arabinofuranosidase activity in Bacillus polymyxa are β-arabinofuranosidase (sal. *et al* .,1995) were genetically characterized for production the bacteria are only.

Application of Xylanase

Xylanase is widely used, including biopulp enrichment, production of wood raw materials, ethanol, methane, and other products, and food processing (Nunez *et al* ., 2001; Haq *et al* ., 2002; Bocchini *et al* ., 2003). This enzyme is very important from an economic point of view, as described below (Motta *et al* ., 2013).

Paper industry

Xylanase processing of cellulose, especially chemical cellulose, has proven to be a biological bleaching process that can increase the gloss and viscosity of the processed pulp and reduce the consumption of chlorine and other bleaching agents. The next level of whitening. Thus, xylanase treatment has been shown to improve the properties of the pulp and reduce the environmental impact of the bleaching process compared to conventional pulp bleaching processes. Conventional disinfection methods. The biggest problem with paper recycling is that ink gets into the paper and loses its luster. The use of recycled fibers has increased over the past decade and descaling is the most important step [Welt and Dinus, 1998]. The current descaling process is based on the use of many environmentally harmful chemicals such as NaOH, Na2SiO3, Na2CO3, H2O2, chelating agents and surfactants [Zhang et al., 2008; 6]. Chemical disinfection methods generate toxic wastewater, which increases the COD of the water and causes costly wastewater treatment [Zhang et al., 2008;Pathak et al., 2011]. The chemical mining industry mainly uses chlorine-based chemicals. Residual chlorine remains on paper and paper products as a result of chemical degreasing; therefore, chlorine-free paper and paper products are necessary [Shoham et al., 1992; Taspinar and Kolankaya 1998].

Detoxification with microbial enzymes

Enzymes are used as an alternative medicine to overcome technological problems associated with the environment [Srinivasan and Rele., 1999]. To overcome this disadvantage, enzyme rejection has received a lot of attention due to its high efficiency and low environmental impact [Thomas, 1994; Pala et al., 2006]. Biological bleaching with enzymes can replace the use of chlorine and chlorine compounds in the bleaching process. [Casimir-Schenkel., 1999] He reported the use of white rot fungi to break down residual lignin in cellulose using lignolytic enzymes such as manganese peroxide and varnish, or hemicellulose-degrading enzymes such as xylanase. Azerite et al., (2010) Bacillus sp. We report the initial xylanase doses for three strains (Ag12, Ag20 and Ag32). For bio-bleaching kraft cellulose at an optimal dose of 60 ° C, pH 9.0, and a pulp concentration of 5.0%, the observed enzyme was 10.0 IU / year. Treated and untreated Ag12, Ag20 and Ag32 slurries (before EDTA and peroxide treatment) reduced kappa number and increased gloss by 7.04 (27.4%), 3.72 (61.7%) and 2.39 (75.3 %). ISO units: 80 (1.0%), 80.5 (1.5%) and 82 (3.0%), respectively.

Xylanase in the production of fruit juices

The production of fruit and vegetable juices is important from a commercial and human health point of view. Thus, by selling juice throughout the year, it is easier to reach a wide range of consumers with the nutrients found in fruits and vegetables. The production of fruit juices (Sharma and Chand 2012c) and vegetable juices requires extraction, purification and stabilization methods. When the fruit industry began producing juice in the early 1930s, yields were low and many struggled to filter the juice to acceptable clarity (Uhlig 1998). Extracellular xylanase activity was generated in the bran as a substrate that could be induced in culture saturated with the fungus Sclerotinia sclerotiorum S2. The enzymes were partially purified and biochemically characterized. The new xylanase activity helps remove orange juice. As an explanation, it was observed that reducing sugars were produced simultaneously after incubating the juice with xylanase for 24 hours. Xylanase helps cleanse the juice and reduces insoluble matter content by 27%. Dhiman *et al* . (2010) Xylanase was obtained from Bacillus stearothermophilus and used to differentiate juices with independent variables.

Xylanase in the food industry

Bread is the most popular traditional food in the world and its production is closely related to enzymes. Enzymes such as malt and mushroom amylase have been used in bread making for many years. Due to changes in the bakery industry and the growing demand for more natural products, enzymes are showing great interest in improving bread dough and quality, as well as in improving the flexibility, stability, quantity and structure of bread. Breadcrumbs for dough (Guy and Sarabjit, 2003). The use of xylanolyte enzymes has increased in recent decades due to their potential effectiveness in baking. Enzymes that hydrolyze starchy and non-starchy carbohydrates are commonly used by bakers as bread expanders (Javier *et al* .). 2007). The role of xylanase in bread production has been intensively studied in recent years (De Schyver *et al* . 2008). Enzymatic hydrolysis of polysaccharides other than starch increased the rheological properties of the dough, the specific volume of the bread and the hardness of the bread crumbs. Xylanase converts water-insoluble hemicellulose into a soluble and water-binding form in the dough to reduce the hardness of the dough, increase its volume and create finer, more uniform crumb. This significantly improves production conditions. The fabric does not stick to the finished parts, which makes it "machine-like" (Rouax1993). Xylanase can directly or indirectly increase the strength of the gluten network and improve the quality of finished bread. Although the full mechanism of action of hemicellulase, pentosanase or xylanase in cake preparation is not well understood, the addition of certain types of pentosanase or xylanase in appropriate doses increases the workability of the dough, making it more flexible and easier to use. This makes the dough more viscous, more stable, more viscous and gives more volume and baking feel.

Xylanase in the live feed industry

Xylanase has generated considerable research interest due to its potential industrial uses. Animal food increases body weight (Medel *et al* . 2002). Xylanase breaks down grain cell walls and improves nutrient absorption. Xylanase increases the use of grain by-products in feed formulations to reduce feed costs. The addition of enzymes to feed can provide economic benefits by facilitating the digestion of low quality foods and reducing nutrient loss due to excretion, increasing poultry efficiency and reducing the nutritional value of feed. Enzymes are added to animal feed to improve digestibility, remove anti-nutrients, increase nutrient availability, and for environmental reasons (Costa *et al* . 2008).

Xylanase is converted into Biofuel

In this case, a large amount of available agricultural industrial waste is effectively used to produce value-added products of different properties with biotechnology, such as biofuels using microbial strains or biocatalysts, organic solvents, microbial enzymes and other metabolism This is more than conventional in chemical methods. All photosynthetic materials are made of simple carbohydrates, but they exist in the form of polymers of cellulose, hemicellulose, and lignin, and they are intricately intertwined. Therefore, their digestion to produce simple monomer forms requires a strong acidic or alkaline environment. This chemical hydrolysis method will produce xenobiotic emissions and cause environmental pollution. The use of specific hydrolases provides a better solution. Among the different hydrolytic enzymes of hemicellulose materials, xylanase is becoming more and more important due to its wide application in various industrial sectors, especially in the biological conversion of hemicellulose waste into ethanol, xylitol and arabitol. , In addition to the application in animal feed and different biotechnology applications. (Subramaniyan & Prema 2002).

Xylanase in the textile industry

The use of enzymes in the textile industry is one of the fastest growing areas of industrial enzymology. The enzymes used in the textile industry are xylanase, amylase, catalase and lactase, which are used to remove starch, degrade excess hydrogen peroxide, bleach fabrics and degrade lignin. With the increasing availability of enzymes, their applications in various fields of textile processing are developing rapidly. The textile industry can benefit greatly from the expanded use of these enzymes because they are non-toxic and environmentally friendly. The removal of non-cellulosic compounds from bast fibers, such as lignin and hemicellulose, can be solved by using a mixture of xylanase and cellulase. After using this method, there is no need to use a strong bleaching step, otherwise it will cause the fiber to turn black (Polizeli *et al* ., 2005).

Current research focuses on replacing harsh chemicals with commercial enzymes that can specifically target non-cellulose and hemicellulose impurities while maintaining standard production results in the textile industry (Li and Hardin 1998; Hartzell and Hsieh 1998; Etters 1999; Traore and Buschle-Diller 1999; Buchert *et al* . 2000; Csiszar *et al* . 2001a; Yachmenev 2001; Lenting *et al* . 2002; Agrawal *et al* . 2004; Borrow etc. 2004; Diman *et al* . 2008). Enzyme treatment can significantly improve the water absorption properties of fibers by removing complex impurities located in the primary cell wall. Pretreatment of low-quality jute fibers with pure thermosetting xylanase is attractive for selective xylan removal without affecting fiber strength during the spinning process (Saha 2000). There are several reports mentioning the use of cellulase and pectinase for tissue bioprocessing, but there are few reports on the use of xylanase for decalcification and degreasing (Csiszar *et al* ., 2001b; Losonczi *et al* ., 2005) . Fabric processing includes loosening (removing adhesive sizing material), scrubbing (improving fabric absorbency and whiteness), and bleaching (given a fixed standard whiteness to the fabric) (Karmakar 1999; Rouette 2001). Sizing materials (ie starch, wax, etc.) protect the fabric from abrasion during the weaving process. Loosening is carried out to remove the adhesive material to make the fabric easier to enter the post-processing stage. Usually, it is carried out in an alkaline solution with a strong oxidant at a higher temperature. After sizing, the fabric must be washed to remove inhibitory substances for effective finishing, wetting and dyeing (Harris *et al* ., 1998).

Future Outlook

In the future, the focus will be on the proper and economical use of the abundant xylan and xylanse compounds. Due to industrialization and urbanization, these compounds accumulate in the environment. The paper industry and agricultural activities release large amounts of xylan, which are deposited in rivers and ponds. Therefore, in order to maintain the ecological balance and meet the increasing demand for fuel and energy, attention must be paid to properly converting these waste hemicellulose compounds into renewable energy and biofuels (Biely 1985; Niehaus *et al* . 1999; Monica *et al* . .Al. 2004; Inoue *et al* . 2008). In-depth understanding of the molecular aspects of xylanase and cloning into a suitable expression vector will be the second main goal. The reason for this is that new industrial uses of xylanase have been explored, and this type of xylanase is required to be stable and active in a wide range of pH and temperature; therefore, it encodes a thermophilic alkali The gene for sex xylanase will be cloned for industrial purposes. There are few reports on the molecular aspects of xylanase and molecular cloning to increase yield and synthesize xylanase with desired characteristics (Kulkarni *et al* . 1999; Liu *et al* . 2003; Huang *et al* . 2006). In order to construct an expression vector that can be used to express the desired type of xylanase, it is necessary to use the latest technology in the field of protein engineering. A major obstacle to the commercialization of enzymatic processes is the large-scale production of enzymes at a profitable rate. In order to achieve this goal, it is necessary to explore strategies to achieve profitable mass production. Therefore, the next few years will see advances in production methods to take advantage of those microbial species that can easily metabolize usable waste at an affordable price using the simplest technology. Great progress has been made in understanding the basic mechanism of xylanase and modifying its characteristics. In order to bring about this revolution in production and industrial applications, biotechnologists, microbiologists and biochemists should work together for the future.

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