Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

Article Review: Microbial Cellulases: Types and Applications

Hiba T. Rasheed

Department of Biology, College of Science,University of Wasit, Wasit, Iraq

Email: hibataqi211986@gmail.com

ORCID ID: https://orcid.org/0000-0003-0190-803x

Abstract

There was a diverse range of microorganisms, including fungus, bacteria, and actinomycetes, release a complex group of enzymes known as cellulases. Cellulose is destroyed by cellulases. Endoglucanase, exoglucanase, and -glucosidase must cooperate for cellulase to function properly. Numerous industries, including the food industry, the textile industry, the paper and pulp industry, and the production of biofuels, use cellulase. Because of the importance of cellulase this review discuses the basic point about this enzyme.

Key words: cellulose, cellulase, Microbial cellulases and Types of cellulases.

1-Introduction

A significant portion of the industrial enzymes are microbial cellulases, which are used in many different industries. Cellulases are being used more frequently recently to produce fuel from biomass, which results in improved yields and unique activities. The cost of producing cellulase must be reduced in order to increase the economics of such procedures, which may be accomplished by developing better bioprocesses and genetically enhancing cellulase producers. Cellulases are a group of enzymes that break down cellulose. Cellulase is a complex enzyme that requires the cooperation of endoglucanase, exoglucanase, and β-glucosidase. Several microorganisms, primarily bacteria and fungi, produce this enzyme. These microbes are well-known for their numerous industrial and medical applications **(1).** Due to the rising need for energy, food, and chemicals, biotechnology currently faces a significant challenge with the bioconversion of raw materials that contain cellulose. Cellulases are enzymes produced by microorganisms while they grow on cellulosic materials and hydrolyze the -1, 4-glycosidic bond of cellulose **(2).**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

2- Types of cellulases

Based on the type of reaction catalyzed, there are five general categories of cellulases **(3).**

1. Endo-cellulase disrupts internal links to reveal individual cellulose polysaccharide chains and disturb the crystalline structure of cellulose.
2. The enzyme exo-cellulase cleaves Tetrasaccharides or disaccharides, such as cellobiose, are generated by endocellulase at 2-4 units from the ends of the exposed chains.
3. Exo-cellulases, also known as cellobiohydrolases, can be divided into two broad categories: those that work processively from the reducing end of cellulose and those that work processively from the non-reducing end.
4. The exo-cellulase product is hydrolyzed into distinct monosaccharides by cellobiase or beta-glucosidase.
5. Oxidative cellulases, such as cellobiose dehydrogenase, that depolymerize cellulose through radical reactions (acceptor).

3- Cellulolytic microorganisms

Using a multienzyme system, a variety of microorganisms participate in the hydrolysis of cellulose. The following list includes some of the best-characterized cellulase systems: *Phanerochaete chrysosporium*, *Fusarium solani*, *Penicillum funiculosum*, *Talaromyces emersonii*, *Trichoderma koningii*, and *Trichoderma reesei* are examples of soft-rot fungi. The following list includes some of the aerobic cellulolytic bacteria with the best-characterized cellulase systems: *Cellulomonas* sp., *Cellvibrio* sp., *Microbispora bispora* and *Thermomonospora* sp. Examples of anaerobic cellulolytic bacteria are as follows: *Acetivibrio cellulolyticus, Bacteroides cellulosolvens, Bacteriodes succinogenes, Clostridium thermocellum, Ruminococcus albus* and *Ruminococcus flavefaciens*. The majority of cellulase-producing microorganisms are fungi, while a small number of bacteria and actinomycetes have also been identified. Cellulase-producing fungi from genera like *Trichoderma* and *Aspergillus* are well known, and the raw enzymes they manufacture are readily available for use in agriculture **(4).**

A considerable amount of cell free cellulase, which can hydrolyze cellulose into fermentable soluble sugars like glucose a crucial raw material in the chemical industries—is produced when the genus *Aspergillus* species attack cellulose. It is generally known that *Aspergillus* and *Trichoderma* specie produce cellulases effectively **(4).** Mandels and Reese conducted a

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

number of research to manufacture cellulolytic enzymes from the biowaste degradation process by numerous microorganisms, including fungus like *Trichoderma*, *Penicillium*, and *Aspergillus* species, etc **(5).**

4- Cellulase Applications

This is an essential tool for conducting research in the paper, textile, animal feed, biofuel, and detergent industries.

4- 1- Textile Industry

Cellulases are one of the most significant groups of enzymes used in industry, and they have been used to soften and minimize the faded appearance and projecting fibers in fabrics and clothing. Prior to that, this was generally accomplished with pumice stone **(6).** Along with proteases and trichoderma, cellulases from *Humicola insolens* are widely utilized in bio-stoning. Cellulases provide a superior finish and break down the tiny fibers that give fabric its rough appearance. They have been used for fabric softening and defibrillation. Fiber color fluctuation is eliminated by the use of cellulases, which are effective localizing agents **(7).**

4-2- Detergents and Laundries

Excellent cleaning capabilities make cellulases CBH I and EG III useful for cleaning textiles. According to reports, detergent modifications work well with T. reesai EG III variations. In a manner similar to *A. niger*, *T. harzianum* and *T. viride* are also utilized as naturally occurring sources of cellulases **(8).** *Humicola* species (*H. grisea* and *H. insolens*) can produce cellulase at mild alkaline conditions and at high temperatures. So they are primarily added to detergents and washing powders as additives. Detergents are formulated with cellulases to break down hydrogen bonds under abrasive environmental conditions like alkaline or thermophilic environments **(9).**

4-3- In Food Industry

Cellulases are used in the food sector to clarify and extract olive oil, fruit juices, vegetable juices, and fruit nectars **(9).** Glucanases are used as additives in the brewing industry to enhance the malting of barley. The use of glucanase and hemicellulose allowed for the decent extraction and maceration of color. Cellulases are able to extract carotenoids, which have been utilized as food coloring additives. Cellulases, pectinases, and hemicellulases have all been employed to alter the nutritional value of forages. Animal feed's ability to be digested and its performance have been said to improve when cellulases are used. Trichoderma

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

cellulases were found to improve the digestibility and feed conversion ratio of cereal feed, according to Bedford *et al.* **(10)**.

4-4- In Paper and Pulp Industry

Hemicellulases and cellulases have been employed in the paper and pulp industry to change the biochemical pulping of coarse pulp and to enhance strengthening **(11).** These are equally helpful for improving efficiency and draining paper mills as they are for depolarizing recycled pulp. Cellulases have been used to get rid of coatings and toners on paper. Additionally, microbial cellulases have been utilized to characterize pulp made from fibers. Cellulases are simple to employ in the production of biodegradable cardboard and can also be used to enhance the softness of paper, sanitary napkins, and paper towels **(12).**

4-5- Biofuel Production

One of the most recently researched uses of cellulases in the bioconversion of lignocellulosic wastes is the production of biofuel. Although there are plenty of cellulosic wastes accessible, the cost effectiveness of the biodegradation process is a key drawback. Lignocellulosic material can be transformed by cellulases into fermentable sugars like glucose and maltose, which are utilized as substrates to create bioethanol and other products. There have been reports of certain bacteria that can directly convert biomass into different alcohols **(13).** However, they are not utilized as effectively in the marketplace. This process uses several steps to turn lignocellulosic material into bioethanol. Hemicellulose and lignin fractions are enhanced for further processing during the pretreatment process. Microorganisms have been used to turn cellulosic wastes into alcohol in the penultimate phase after the residues have been degraded at 50°C to yield fermentable sugars **(14).**

5- Cellulase activity assay

For measuring cellulase activity (CA) in soils and microbiological cultures, a new technique has been created. This procedure is based on the measurement of the loss in strength of a cellophane membrane (Proc. USSR Acad. Sci. Ser. Biol. 3 (1988) 466-471) and has been calibrated with cellulase enzyme activity, so that it is now possible to relate the decline in membrane strength to units of cellulase enzyme. The calibration curve was used to convert the data obtained in relative units (atm h-‘) to standard enzymatic units (pg reduced sugars (red.sug.) ml-’ h-l). Using group-specific antibiotics: actidione and chloramphenicol the method was applied to estimate the differential contribution of soil fungi, bacteria and

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

extracellular enzymes to cellulose decomposition in soil **(15).**

6-Conclusion

The recent development in cellulase applications is truly astonishing and gaining attention on a global scale. It already has an insurmountable hold on the world market. Because of their enormous potential for producing cellulases, microbes are a fascinating subject of study for the development of these enzymes. The potential for microbial cellulases to be used in a wide range of sectors makes them the favored choice. Their businesses are growing every day. To address the rising demand for microbial cellulase, more and more studies are needed to create scientific information.

References

1. ZYH. Percival, ME. Himmel, JR. Mielenz. Outlook for cellulase improvement: screening and selection strategies. Biotechnol Adv.vol.24(5),pp.452–481,2006.
2. Lee SM and Koo YM. Pilot-scale production of cellulose using Trichoderma reesei Rut C-30 in fed-batch mode. J. Microbiol. Biotechnol., 11: 229-233,2001.
3. P.Saranraj*, D. Stella and D. Reetha.MICROBIAL CELLULASES AND ITS APPLICTIONS: A REVIEW , International Journal of Biochemistry & Biotech Science; 1: 1-12,2012.
4. N,Peij, Gielkens, MMC,RP,Verles and LH,Graff. The transcriptional activator xin R regulates both xylanolytic endoglucanase gene expressions in Aspergillus niger. Applied Environ. Microbiol., 64: 3615-3617,1998.
5. M,Mandels andET, Reese. Fungal cellulase and microbial decomposition of cellulosic fibres. Dev. Ind. Microbiol., 5: 5-20,1985.
6. M.K. Bhat. Cellulases and Related Enzymes in Biotechnology. Biotechnology Advances, 18, 355-383,2000.
7. L.L., Kvietok, T.Trinh, and J.A. Hollingshead Cellulase Fabric-Conditioning Compositions. US Patent No. 5445747,1995.
8. B.Kottwitz, and F,Schambil,. Cellulase and Cellulose Containing Detergents. US Patent No. 20050020472,2005.
9. E. Pajunen. Optimal Use of β-Glucanases in Wort Production. In: EBC-Symposium on Wort Production, Monograph XI, Maffliers, France, 137-148,1986.
10. M.R., Bedford, A.J., Morgan, T.,Fowler, Clarkson,M.A., Ward, K.D. Collier, and E.A. Larenas. EnzymeFeed Additive and Animal Feed Including It. US Patent No. 6562340

Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 2962 - 2967
Received 08 November 2021; Accepted 15 December 2021.

(to Genencore International Inc., USA),2003.

11. M. Akhtar. Biochemical Biomechanical Pulping of Aspen Wood Chips with Three Strains of Ceriporiopsissubvermispora. Holzforschung, 48, 199-202,1994.
12. M.Salkinoja-Salonen. Method for Manufacturing Paper or Cardboard and Product Containing Cellulose. US Patent No. 4980023 (to Enso-Gutzeit Oy, Helsinki, FI),1990.
13. S., Kundu, T.K. Ghose, and S.N. Mukhopadhyay. Bioconversion of Cellulose into Ethanol by Clostridium thermocellum—Product Inhibition. Biotechnology and Bioengineering, 25, 1109-1126,1983.
14. S.K., Rani, M.V. Swamy, and G.Seenayya. Increased Ethanol Production by Metabolic Modulation of Cellulose Fermentation in Clostridium thermocellum. Biotechnology Letters, 19, 819-823,1997.
15. A.M. Semenov, B.P. Batomunkueva, D.V. Nizovtseva, N.S. Panikov.Method of determination of cellulase activity in soils and in microbial cultures, and its calibration Journal of Microbiological Methods 24 , 259-267,1996.