Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2011 Vol. 1 (4) October-December, pp.180-186/Vuppu and Mishra

Review Article

AN OVERVIEW OF SOME REPORTED SOIL ENZYME PRODUCING MICROORGANISMS

***Suneetha Vuppu and Bishwambhar Mishra**
School of Bio Sciences and Technology, VIT University, Vellore- 632 014, Tamil Nadu, INDIA
**Author for Correspondence*

ABSTRACT

Soil Microorganisms as potential source of novel and or improved products of commercial importance have gained utmost prominence in Microbial technology and bioprocess engineering. The mail target of enzyme technology is the microorganism itself, which have the capacity to produce commercially important enzymes on industrial scale, as enzymes occupy the center theme in all biological processes. Microbial enzymes are generally cheaper to be produced and are obtained in high yields. Their contents are more predictable and reliable supply of products of constant composition is more easily available from microorganisms as their growth rate is comparatively fast and enzymes with identical substrate profile produced by different microorganisms vary significantly in the optimal conditions for their reactions like temperature, pH, substrate concentration etc. This gives flexibility in their utilities. Soil is a natural lab for screening of microbial enzymes Like Pectinase, keratinase, Xylanases and Lipases. Soil Enzymes are the biocatalysts which mediate all the synthetic and degradative reactions in living organisms. They increase the rate of slow and imperceptible reactions without undergoing any net change and are remarkable because of their extraordinary specificity, inducible nature, and catalytic power and soil enzymes.

Key Words: *Microbial technology, Pectinases, Keratinases, Xylanases, Inducible nature, Catalytic power*

INTRODUCTION

Biotechnological answers for environmental sustainability are modern solutions that help in the growth of the nation and are a boon for the welfare of human beings for the present and forthcoming generations. Soil Enzymes are usually offered as “cocktails” of several activities rather than a single enzymatic activity (Agarwal *et al.* 2008). However, in many cases the enzyme activities can still act on the same composition, as the composition can have a complex chemical structurehaving various types of chemical bonds, requiring different enzyme activities forbreakdown. Application of biotechnology to industrial operations for enzyme production is no longer an academic or potentially useful alternative proposition for the future (Suneetha *et al.* 2011).

Microbial soil Enzymes have become big business, with a wide range of industries using commercial enzymes, in addition to the feed industry. The world annual sales of industrial enzymes were recently valued at $1 billion. Three-quarters of the market is for enzymes involved in the hydrolysis of natural polymers.Thus we attempted a study to screen and report the soil enzymes producing microbes (Evans *et al.* 2000; Ichida *et al.* 2001; Rozs *et al.*2001). To days enzyme technology mostly depends on microbes like bacteria and actinomycetes and potential Microorganisms are highly susceptible to genetic manipulations and hence provide ample scope for strain improvement and for further investigation.

Microorganisms Producing Pectinases

Pectinases are a group of enzymes that hydrolyze the pectic substances, present mostly in plants. Although they can be derived from several sources, such as plants, animals and micro-organisms, the enzymes from microbial sources (Table 1) generally meet industrial demands.

Microorganisms Producing Xylanases

The xylanases have been reported mainly from bacteria, fungi, actinomycetes and yeast which have been listed in the Table 2.Owing to the increasing biotechnological importance of thermostable xylanases,

Table 1: Some of the reported pectinase producing microorganisms

Organisms	Strain Names	References
Fungi	*Fusarium solani*	Agarwal *et al.* (2008)
	Aspergillus flavus	Sangeeta *et al.* (2008)
	Rhizomucor sps, N3	Natalia *et al.* (2007)
	Sclerotium rolfsii	Schnitzhofer *et al.(*2006)
	Aspergillus sojae ATCC 20235	Tari *et al.* (2006)
	Aspergillus awamon	Carolina *et al.* (2006)
	Penicillum viridicatum	Denis *et al*.(2005)
	Sporotrichum Thermophile apinis.	Guneet *et al*.(2004)
	Collectrichun lidemuthianum	Corentin *et al.* (2003)
	Penicillium frequentans	Maria *et al*.(2001)
	Venturia inaequalis	Kollar *et al.*(1997)
	Aspergillus niger	Angelova *et al.*(1997)
	Botrytis cinerea	David *et al*.(1992)
	Glomus mosseae	Garicia *et al.* (1991)
	Pencillum capsulaturn	Gillespie *et al.* (1990)
Bacteria	*Bacillus subtilis* WSHB04-02	Qiang Wang (2006)
	Bacillus pumilus dcsr1	Sharma *et al.*(2005)
	Bacillus sp. DT7	Kashyap *et al.* (2002)
	Bacillus sp. NTT33	Junwei *et al*.(2000)
Actinomycetes	*Streptomyces Sps*	Suneetha. (2011)
	Streptomyces Sps.	Suneetha *et al.* (2004)
	Streptomyces sp. RCK-SC	Kuhad *et al.*(2003)
	Streptomyces sp. QG-11-3	Qasim *et al.* (2000)
	Thermomonospora flisca	Stutzenberger F.J. (1987)

many thermophilic microorganisms had been examined for xylanases production. Bacteria are of great importance in xylanse production industrially because of the ease in screening, less incubation period, ability to withstand high pH and temperature etc. The different bacteria are reported to produce xylanases are, *Bacillus*, *Pseudomonas*, *Cellulomonas*, *Arthrobacter*,*Geobacillus* species etc.

Microorganisms Producing Keratinases

Keratinases are group of proteases acting specifically on the fibrillar intermediate protein keratin. Keratin is the insoluble sulfur rich structural protein found almost in pure form in the outer epidermal appendages and layers like hair, feather, nails, wool, horn, hoofs etc. Native keratins including feather and hair are resistant to common proteolytic enzymes like trypsin, pepsin, papain, chymotrypsin and also many other microbial proteases.The keratinase producing microbes have been summarized in Table 3.

Microorganisms Producing Lipases

Lipases are produced by many microorganisms and higher eukaryotes. Most commercially useful lipases are of microbial origin. Lipase-producing microorganisms (Summerized in Table 4) have been found in diverse habitats such as industrial wastes, vegetable oil processing factories, dairies, soil contaminated

Table 2: Some reported xylanase producing microorganisms

Organisms	**Strains**	**References**
Fungi	*Penicillium oxalicum*	Muthezhilan *et al.* (2007)
	Thermomyces lanuginosus	Jiang *et al.* (2004)
	Aspergillus tamari	Daniela Farani de Souza (2001)
Bacteria	*Geobacillus thermoleovorans*	Sharma *et al.* (2007).
	Bacillus sp.	Anuradha *et al.* (2007)
	Pseudomonas species	Zheng-Hong Xu, *et al.* (2005)
	Bacillus coagulans	Choudhury *et al.* (2005)
	Arthrobacter sp MTCC 5214	Khandeparkar *et al.* (1988)
Actinomycetes	*Actinomyces*	Suneetha *et al.* (2003)
	Streptomyces olivaceoviridis E-86	Ding *et al.* (2004)
	Streptomyces sp.	Rifaat Rawashdeh (2005)

with oil, oilseeds, and decaying food, compost heaps, coal tips, and hot springs. Lipase-producing microorganisms include bacteria, fungi, yeasts, and actinomyces.Thus this study helps to know some of the reported microorganisms for our further study. Lipases are produced by many microorganisms and higher eukaryotes. Most commercially useful lipases are of microbial origin. Lipase-producing microorganisms have been found in diverse habitats such as industrial wastes, vegetable oil processing factories, dairies, soil contaminated with oil, oilseeds, and decaying food, compost heaps, coal tips, and hot springs. Lipase-producing microorganisms include bacteria, fungi, yeasts, and actinomyces.

Bacterial Lipases

A relatively smaller number of bacterial lipases have been well studied compared to plant and fungal lipases. Bacterial lipases are glycoproteins, but some extracellular bacterial lipases are lipoproteins. Among bacteria, *Achromobacter* sp., *Alcaligenes* sp., *Arthrobacter* sp., *Pseudomonas* sp., *Staphylococcus* sp., and *Chromobacterium* sp. have been exploited for the production of lipases.

Fungal Lipases

Fungal lipases have been studied since 1950. These lipases are being exploited due to their low cost of extraction, thermal and pH stability, substrate specificity, and activity in organic solvents. The chief producers of commercial lipases are *Aspergillus niger*, *Candida cylindracea*, *Humicola lanuginosa*, *Mucor miehei*, *Rhizopus arrhizus*, *R. delemar*, *R. japonicus*, *R. niveus* and *R. oryzae*.

Actinomycetes Lipase

Although bacteria has the highest total population in soil followed by Actinomycetes and fungi, the largest population of lipase-producing microorganisms was actinomycetes followed by bacteria and fungi. The frequencies of lipase-producing bacteria, *Actinomycetes* and fungi were 8.5, 55.9, and 23.3%, repespectively. Although little research has been published on lipolytic activity in *Streptomyces* considering their widespread use within antibiotic production, activity has been detected. Lipase production in a wide range of *Streptomycetes* have been investigated however lipolytic activity was found in only a few strains tested.

Table 3: Some of the Reported Keratinase Producing Microorganisms

Organisms	**Strains**	**References**
Fungi	*Absidia sps. , A.gluaca, A..cylindrospora*	Kunert (1988); Rajak *et al.*(1992)
	Arthrodermo gloriae	Kunert *et al.* (1992)
	Chrysosporium georgiae	El Naghy *et al*, (1998) ; Singh, *et al.*(2003)
	Ctenomyces serratus	Kunert *et al.* (1988)
	Cunninghamella elegans	Kunert *et al.* (1988)
	Cylindricarpon lichenicolar	Malviya *et al.*(1992)
	Gliocladium sps.	Kaul *et al.*(1997)
	Graphium penicilloideus	Malviya *et al.* (1993)
Bacteria	*Bacillus sps.- B.licheniformis, B.holodurans,*	Evans *et al.* (2000) ; Ichida *et al.* (2001) ; Rozs *et al.* (2001)
	Chryseobacterium sps.	Riffel *et al.*(2003)
	Fervidobacterium pennavorans	Friedrich *et al.*(1996
	Flavobacterium sps.	Riffel *et al.*(2003)
	Kocuria rosea	Vidal *et al.*(2000)
	Thermoanaerobacter keratinophilus	Riessen *et al.*(2001)
	Xanthomonas maltophilia strain (POA-1)	Detoni *et al.*(2002)
Actinomycetes	*Doratomyces microsporus*	Vignardet *et al.*(1999) ; Gradisar *et al.*(2000)
	Streptomyces sps. .	Suneetha (2011)
	Thermoactinomyces sps. Thermoactinomyces candidus	Ignatova, *et al.* (1999)

Table 4: Lipase producing Actinomycetes

Organisms	**Strains**	**References**
Actinomycetes	*Streptomyces fradiae* NCIB 8233	Sztajer *et al.*(1988)
	Streptomyces sp. PCB27	Sztajer *et al.*(1988)
	Streptomyces sp. CCM 33	Sztajer *et al.*(1988)
	Streptomyces coelicolor	Hou CT (1994)

Summary and Conclusion

Soil Microorganisms as potential source of novel and or improved products of commercial importance like enzymes have gained utmost prominence in biotechnology. The prime focus of enzyme technology is the microorganism itself, which have the capacity to produce commercially important enzymes on industrial scale, as enzymes occupy the center stage in all biological processes. In light of this new screening systems are being continuously and extensively utilized to isolate strains from soil by baiting and enrichment technique which produce novel products or improved yields of the important products that can be further developed upon by strain improvement using conventional as well as rDNA techniques. Application potential of the soil enzymes from the native or improved strains in the condition employed in the various industry can boost the possibility of development of indigenous soil enzyme technology

REFERENCES

Agrawal PB, Nierstrasz VA, Warmoeskerken MMCG (2008). Role of mechanical action in low-temperature cotton scouring with *F. solani pisi* cutinase and pectate lyase, *Enzyme and Microbial Technology* **42** 473–482.

Angelova M, Sheremetska P, Lekov M (1998). Enhanced polymethylgalacturonase production from *Aspergillus niger* 26 by calcium alginate immobilization, *Process Biochemistry* **33** 299-305.

Anuradha P, Vijaylakshmi K, Prasanna ND (2007). Production and properties of alkaline xylanase from *Bacillus* species isolated from sugar cane fields, *Current Science*. **92** 1283-1286.

Aparna S, Gupta MN (2001). Purification of pectinases by three-phase partitioning *Biotechnology Letters* **23** 1625–1627.

C.H. Ding, Z.Q. (2004). High activity xylanase production by *Streptomyces olivaceoviridis* E-86, *World Journal of Microbiology & Biotechnology* **20** 7–10.

Carolina B, Ana D, Ignacio de O, Colin W, Ana B (2007) . Xylanase and pectinase production by Aspergillus awamori on grape pomace in solid state fermentation, *Process Biochemistry* **42** 98–101.

Corentin H, Richard OC, Elodie G, Vincent S, Marie-Therese ET,Bernard D (2004). Production of a cell wall-associated endopolygalacturonase by Colletotrichum lindemuthianum N and pectin degradation during bean infection , *Fungal. Genetics and Biology* **41** 140–147.

Daniela Farani de Souza (2001). Effect of easily metabolizable sugars in the production of xylanase by *Aspergillus tamarii* in solid-state fermentation, *Process Biochemistry* **36** 835–838

David JJ, Brian W (1992). An immunological study of the induction of polygalacturonases in *Botrytis cinerea, FEMS Microbiology Letters* **97**19-23.

De nis S, Kivia T, Eduardo da SM, Roberto DS, Eleni G (2005). Production of pectinase by solid-state fermentation with Penicillium viridicatum RFC3, *Process Biochemistry* **40** 2885–2889.

De Toni CH, Richter MF, Chagas JR, Henriques JAP, Termignoni C(2002). Purification and characterization of an alkaline serine endopeptidase from a feather-degrading Xanthomonas maltophila strain, *Canadian Journal of Microbiol* **48** 342–348.

El-Naghy MA, El-Ktatny MS, Fadl-Allah EM, Nazeer WW(1998). Degradation of chicken feathers by Chrysosporium georgiae, *Mycopathologia* **143** 77–84.

Friedrich AB, Antranikian G (1996). Keratin degradation by Fervidobacterium pennavorans, novel thermophilic anaerobic species of the order thermotogales, *Applied Environmental Microbiology* **62** 2875–2882.

Garcia R, Garcia Garrido JM, Ocampo JA (1991). Pectolytic enzymes in the vesicular-arbuscular mycorrhizal fungus *Glomus mosseae, FEMS Microbiology Letters*,**78**343-346.

Gillespie A,Cook K, Coughlan MP (1990).Characterization of an endopolygalacturonase produced by solid-state cultures of the aerobic fungus *Penicillium capsulatum*, *Journal of Biotechnology* **13** 279-292.

Gradisar H, Kern S, Friedrich J (2000). Keratinase of Doratomyces microspores, *Applied Microbiology and Biotechnology* **53** 196–200.

Guneet K, Sanjeev K, Satyanarayana T (2004). Production, characterization and application of a thermostable polygalacturonase of a thermophilic mould Sporotrichum thermophile Apinis, *Bioresource Technology* **94** 239–243.

Hou CT (1994) . pH dependence and thermostability of lipases from cultures from ARS culture collection, *Journal of Industrial Microbiology* **13** 242–248.

Ignatova Z, Gousterova A, Spassov G, Nedkov P (1999). Isolation and partial characterization of an extracellular keratinase from a wool degrading thermophilic actinomycete strain *Thermoactinomyces candidus*, *Canadian Journal of Microbiology* **45** 217-222.

Jiang ZQ,Yang SQ, Yan QJ, Li LT , Tanet SS (2004). Optimizing xylanase production by a newly isolated strain CAU44 of the thermophile *Thermomyces lanuginosus, World Journal of Microbiology & Biotechnology* **21** 863–867.

Junwei C, Weihua S, Yong P, Shuyun C (2000) . High-Producers of Polygalacturonase Selected From Mutants Resistant to Rifampin in Alkalophilic *Bacillus* sp. NTT33, *Enzyme and Microbial Technology* **27** 545–548.

Kashyap DR, Chandra S, Kaul A, Tewari R (2000). Production, purifcation and characterization of pectinase from a *Bacillus sp.* DT7, *World Journal of Microbiology & Biotechnology* **16** 277-282.

Khandeparkar RDS, Bhosle NB (1988). Isolation, purification and characterization of the xylanase produced by *Arthrobacter* sp MTCC 5214 when grown in solid-state fermentation, 1-35

Kollar A (1998) . Characterization of an endopolygalacturonase produced by the apple scab fungus, *Venturia inaequalis , Mycology Resrarch* **102** 313-319.

Kunert J (1989). Biochemical mechanisms of keratin degradation by actinomycete Streptomyces fradiae and fungus Microsporium gypseum, a comparison, *Journal of Basic Microbiology* ***29*** 597-604.

Kunert J (1992). Effects of reducing agents on proteolytic and keratinolytic activity of enzymes of *Microsporium* gypseum, *Mycoses* **35** 343-348.

Malviya HK, Tiwari S, Rajak RC, Hasija SK(1993). Keratinolysis by four fungi isolated from the soil and effluent of a gelatin factory at Jabalpur, *Crypt. Bot.* **3** 108-116.

Maria S, Celestino C, Maria de Freitas S (2006) .Purification and characterization of a novel pectinase from *Acrophialophora nainiana* with emphasis on its Physicochemical properties , *Journal of Biotechnology* **123** 33–42.

Muthezhilan R, Ashok R, Jayalakshmi S (2007). Production and optimization of thermostable alkaline xylanase by *Penicillium oxalicum* in solid state fermentation, *African Journal of Microbiology Research* **5** 020-028.

Qasim KB, Bharat B, Mukesh K, Hoondal GS (2000). Effect of amino acids on production of xylanase and pectinase from *Streptomyces sp.* QG-11-3, *World Journal of Microbiology & Biotechnology* **16** 211-213.

Qiang W, Xue-Rong F , Zhao-Zhe H, Jian C (2007) . Optimizing bioscouring condition of cotton knitted fabrics with an Alkaline pectinase from *Bacillus subtilis* WSHB04-02 by using Response surface methodology , *Biochemical Engineering Journal* **34** 107–113.

Rifaat R (2005). Effect of cultural conditions on xylanase production by *Streptomyces sp.* (strain Ib 24D) and its potential to utilize tomato pomace, *African Journal of Biotechnology* **4** 251-255.

Riffel A, Lucas F, Heeb P, Brandelli A (2003). Characterization of a new keratinolytic bacterium that completely degrades native feather keratin, *Archieve in Microbiology* **179** 258–265.

Rissen S, Antranikian G (2001). Isolation of Thermoanaerobacter keratinophilus sp. novel thermophilic, anaerobic bacterium with keratinolytic activity, *Extremophiles* **5** 399–408.

Sangeeta Y, Pramod KY, Dinesh Y, Kapil DSY(2008). Purification and characterization of an alkaline pectin lyase from *Aspergillus flavus*, *Process Biochemistry* **43** 547–552.

Schnitzhofer W, Weber HJ, Vrsansk M, Biely P, Cavaco-Paulo A, Guebitz GM(2007). Purification and mechanistic characterisation of two polygalacturonases from *Sclerotium rolfsii*, *Enzyme and Microbial Technology* **40** 1739–1747.

Sharma A, Adhikari S, Satyanarayan T (2007) . Alkali thermostable cellulase free xylanase production by an extreme thermophile *Geobacillus thermoleovorans* , *World Journal of Microbiology and Biotechnology* **23** 483-490.

Sharma DC, Satyanarayana T (2006). A marked enhancement in the production of a highly alkaline And thermostable pectinase by *Bacillus pumilus* dcsr1 in Submerged fermentation by using statistical methods, *Bioresource Technology* **97** 727–733.

Stutzenberger FJ (1987). Inducible thermoalkalophilic polygalacturonate lyase from Thermornonospora fusca, *Journal of Bacteriology* **169** 2774-2780.

Suneetha V (2006). Isolation and charaterization of keratinase producing organisms from Trimula and Tirupati. Unpublished PhD thesis. University of SPMVV (Women University), Tirupati.

V.Suneetha (2011) Screening,Characterisation and Optimization of Microbial Pectinase ,Soil Enzymology,Soil Biology-22,G.Shukla and A.Varma (eds) Springer-Verlag BerlinHeidelberg **1** 329-337.

Sztajer H, Maliszewska I, Wieczorek J (1988). Production of exogenous lipases by bacteria, fungi and *actinomycetes*, *Enzyme Microbiology Technology* **10** 492-497.

Tari C, Ogus NG, Tokatli F (2007). Optimization of biomass, pellet size and polygalacturonase production by *Aspergillus sojae* ATCC 20235 using response surface methodology, *Enzyme and Microbial Technology* **40** 1108–1116.

Vidal L, Christen P, Coello MN (2000). Feather degradation by Kocuria rosea in submerged culture, *World Journal of Microbiology and Biotechnology* **16** 551–554.

Vignardet C, Guillaume YC, Michel L, Friedrich J, Millet J (2001). Comparison of two hard keratinous substrates submitted to the action of a keratinase using an experimental design , *International Journal of Pharmacy* **224** 115–122.

Zheng-Hong Xu, Yun-Ling B, Xia X, Jing-Song Shi (2005). Production of alkali tolerant cellulose free xylanse by *Pseudomonas* species WLUN024 with wheat bran as the main substrate, *World Journal of Microbiology and Biotechnology*, **21** 575-581