UNIVERSITI PUTRA MALAYSIA

RUBBER WOOD SAWDUST FERMENTATION BY INDIGENOUS LIGNOCELLULOLYTIC FUNGI FOR CELLULASE PRODUCTION

HUNAIDAH BINTI RAMLI

IPTPH 2019 21

RUBBER WOOD SAWDUST FERMENTATION BY INDIGENOUS LIGNOCELLULOLYTIC FUNGI FOR CELLULASE PRODUCTION

By

HUNAIDAH BINTI RAMLI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

October 2017

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

RUBBER WOOD SAWDUST FERMENTATION BY INDIGENOUS LIGNOCELLULOLYTIC FUNGI FOR CELLULASE PRODUCTION

By

HUNAIDAH BINTI RAMLI

October 2017

Chair : Prof. Rosfarizan Mohamad, PhD
Institute : Tropical Forestry and Forest Product

Microorganisms such as bacteria, fungal or yeast are often used for cellulase production using selected substrates via fermentation. However, relatively expensive cellulose powder as a main substrate hinders the industrial application of cellulase. Lignocellulose has been used as a substrate in producing cellulase as an alternative way towards more economic cost. The use of lignocellulolytic fungal in degradation of the lignocellulose are widely explored and studied due to its ability to produce both cellulase and ligninase. In this study, the potential of lignocellulolytic fungi in producing cellulase were investigated in solid-state fermentation of rubber wood sawdust. Four (4) indigenous fungal strains (*Trichoderma aureoviride* UPM 09, *Fusarium equiseti* UPM 09, *Fusarium proliferatum* UPM 09 and *Aspergillus* sp.) were screened for the best lignocellulolytic enzymes (cellulase and ligninase) producer. Solid-state fermentation of rubber wood sawdust was conducted in batch cultivation using modified Mandel's medium in 250 ml shake-flask. A conventional method (*one-factor-at-a-one-time*) of optimization was applied to obtain maximum production of cellulase. Three parameters of medium optimization (types of nitrogen sources, peptone concentration and tween-80) and four parameters of cultural condition (initial medium pH, temperature, particle size and inoculum size) for cellulase production were investigated.

From the experiments, only *T. aureoviride* UPM 09 and *F. equiseti* UPM 09 exhibit lignocellulolytic enzymes production. Hence, the two strains were selected for rubber wood sawdust fermentation. Throughout the fermentation, *T. aureoviride* UPM 09 showed the highest cellulase production of CMCase (12.99 U/g), FPase (1.57 U/g) and β-glucosidase (5.48 U/g). The optimum medium formulation and culture conditions for cellulase production were obtained using peptone as a sole nitrogen source at 2 g/L with addition of 1 % (v/v) tween-80 and initial medium pH of 5.0 at 25 ˚C. Two agar discs of fungal

culture and 1.7 mm particle size of rubber wood sawdust were used as optimum inoculum and particles sizes. The production of cellulase was increased by 5.5-fold for CMCase (85.04 U/g), 1.9-fold for FPase (4.55 U/g) and 1.7-fold for β-glucosidase (14.92 U/g) using the optimized condition. Enzymatic hydrolysis of different pretreated rubber wood sawdust was carried out to evaluate the performance of crude cellulase activity obtained from the fermentation. The result showed that higher reducing sugar was produced (1.280 mg/ml) using chemical pretreated rubber wood sawdust as compared to biological pretreated rubber wood sawdust (0.577 mg/ml) and raw rubber wood sawdust (0.103 mg/ml). In conclusion, *T. aureoviride* UPM 09 is a high potential strain to be used in cellulase production. The cellulase production by *T. aureoviride* UPM 09 was greatly improved after optimization process which can be further studied using statistical approach.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENAPAIAN SERBUK KAYU GETAH OLEH KULAT LIGNOSELULOLITIK TEMPATAN BAGI PENGHASILAN ENZIM SELULASE

Oleh

HUNAIDAH BINTI RAMLI

Oktober 2017

Pengerusi : Prof. Rosfarizan Mohamad, PhD
Institut : Perhutanan Tropika dan Produk Hutan

Mikroorganisma seperti bakteria, kulat ataupun yis seringkali digunakan untuk penghasilan selulase menggunakan substrat tertentu dalam penapaian. Walaubagaimanapun, serbuk selulase yang mahal sebagai subtrat menjadi penghalang dalam industri penghasilan selulase. Lignoselulosa digunakan sebagai substrat dalam penghasilan selulase sebagai langkah alternatif untuk kos yang lebih ekonomi. Kegunaan kulat lignoselulose dalam penguraian lignoselulosa telah dikaji secara meluas disebabkan kebolehannya menghasilkan kedua-dua enzim selulase dan ligninase. Dalam kajian ini, potensi kulat lignoselulolitik dalam menghasilkan selulas dikaji menerusi penapaian keadaan pepejal serbuk kayu getah. Empat (4) strain asli kulat (*Trichoderma aureoviride* UPM 09, *Fusarium equiseti* UPM 09, *Fusarium proliferatum* UPM 09 dan *Aspergillus* sp.) telah disaring untuk mencari penghasil enzim lignoselulolitik (selulase dan ligninase) terbaik. Dua strain kulat terbaik dipilih untuk penapaian kaedah pepejal serbuk kayu getah bagi penghasilan selulas. Penapaian kaedah pepejal serbuk kayu getah oleh strain-strain itu dijalankan secara selanjar menggunakan media Mandel yang diubah suai di dalam kelalang kon 250 mL. Pengoptimuman cara konvensional (satu faktor satu masa) telah digunakan bagi mendapatkan penghasilan selulase yang optimum. Tiga faktor pengoptimuman media (jenis sumber nitrogen, kepekatan pepton dan tween-80) dan empat faktor keadaan kultur(pH awal media, suhu, saiz partikel substrat dan saiz inokula) untuk penghasilan selulase telah dikaji.

Daripada hasil kajian, hanya kulat *T. aureoviride* UPM 09 dan *F. equiseti* UPM 09 menghasilkan enzim lignoselulase. Maka, dua strain ini telah dipilih untuk penapaian kaedah pepejal serbuk kayu getah. Sepanjang eksperimen dijalankan, *T. aureoviride* UPM 09 telah menunjukkan penghasilan selulase paling tinggi bagi CMCase, FPase dan β-glucosidase dengan aktviti sebanyak

12.99 U/g, 1.57 U/g dan 5.48 U/g berikutan. Pengoptimuman media dan keadaan kultur bagi penghasilan selulas telah diperoleh menerusi pepton sebagai sumber nitrogen pada kepekatan 2 g/L dengan penambahan 1 % (v/v) tween-80 dan pH awal media adalah 5.0 pada suhu 25 ˚C. Dua ketulan agar kulat dan serbuk kayu getah bersaiz partikel 1.7 mm telah digunakan sebagai inokula dan saiz partikel paling optima. Dengan menggunakan keadaan optimum yang diperoleh, penghasilan selulase telah meningkat sebanyak 5.5-fold untuk CMCase (85.04 U/g), 1.9-fold untuk FPase (4.55 U/g) dan 1.7-fold untuk β-glucosidase (14.92 U/g). Hidrolisis enzim serbuk kayu getah yang dirawat dengan cara berbeza telah dibuat untuk menilai aktiviti selulase yang diperoleh melalui proses penapaian. Keputusan telah menunjukkan bahawa gula penurunan paling tinggi dihasilkan (1.280 mg/ml) menerusi serbuk kayu getah yang dirawat dengan perawatan awal kimia berbanding yang dirawat secara biologi (0.577 mg/ml) dan yang tidak dirawat (0.103 mg/ml). Kesimpulannya, *T. aureoviride* UPM 09 adalah strain yang berpotensi untuk digunakan bagi penghasilan selulase. Penghasilan selulase oleh *T. aureoviride* UPM 09 juga telah banyak meningkat setelah proses pengoptimuman dibuat yang mana ianya boleh dikaji lebih lanjut menggunakan cara statistik.

ACKNOWLEDGEMENTS

Alhamdulillah, my sincere appreciation and gratitude goes to my advisor, Prof. Dr. Rosfarizan for her constant guidance, supervision and endless support during my research and study. Big appreciation also goes to my supervisory committee, Assoc. Prof. Dr. Wan Zuhainis and Assoc. Prof. Dr. Umi Kalsum for their guidance and invaluable assistance while serving as committee members.

I would also like to extend my appreciation and special thanks to the staffs & members of Bioprocess Laboratory; En. Rosli, Pn. Noriza, Kak Shira, Kak Shera, Sasirega, Azin, Puva, Shahrul, Kak Farina and my dear friends Hazlinda and Ainu Shahirah for their continuous support and assistance throughout the days in lab.

Last but not least, I would like to express my highest gratitude to my family members who keep supporting me and show me their endless love till the end of my study.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Rosfarizan Mohamad, PhD
Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Chairman)

Wan Zuhainis Saad, PhD
Associate Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Member)

Umi Kalsum Md Shah, PhD
Associate Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Member)

ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 19 December 2019

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: ______________________

Name of Chairman of Supervisory Committee: Prof. Dr. Rosfarizan Mohamad

Signature: ______________________

Name of Member of Supervisory Committee: Assoc. Prof. Dr. Wan Zuhainis Saad

Signature: ______________________

Name of Member of Supervisory Committee: Assoc. Prof. Dr. Umi Kalsum Md Shah (retired)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABTS	2,2'azino- bis -3-ethylbenz-thiazoline-6-sulfonic
BGL	β-glucosidase
BSA	Bovine serum albumin
CBM	Cellulosic basal medium
CMC	Carboxylmethylcellulose
CMCase	Carboxylmethylcellulase
df	Dilution factor
DNS	Dinitrosalicyclic acid
DW	Dry weight
EG	Endoglucanase
EX	Exoglucanase
FPase	Filter paper cellulase
Lac	Laccase
LBM	Lignin modifying enzyme basal medium
LiP	Lignin peroxidase
NREL	National Renewable Energy Laboratory
PDA	Potato dextrose agar
PNP	p-nitrophenol
pPNG	β-glucopyronoside
rpm	rotation per minute
RSM	Response surface methodology
SmF	Submerged fermentation
SSF	Solid state fermentation

UniCC	Unit Culture Collection
UPM	Universiti Putra Malaysia
VP	Versatile peroxidase

CHAPTER 1

INTRODUCTION

The rubber industry in Malaysia has become one of the most important socio-economic sectors since 1957. Apparently, almost 35% of all rubber wood biomass processed remain as waste, which must be exploited efficiently if the industry is to remains competitive in the future (Ratnasingam *et al*., 2012). Malaysia produces abundance of rubber wood sawdust that regarded as wastes, usually from saw milling and furniture industry which accounted almost 2.0 m^3 wastes during 2010 (Ratnasingam and Jones, 2011). Rubber wood sawdust contains high cellulose content with an average of 43 % thus it can be a potential substrate for cellulase production (Shaaban *et al.,* 2013).

Cellulase, one of the important industrial enzymes is widely used in industries such as textile, pulp and paper, animal feed, detergent, brewery and wine as well as agricultural sector (Singh *et al.,* 2016; Kuhad *et al.,* 2011). Besides that, recent studies show promising results of cellulase application in biofuel industry (Srivastava *et al*., 2015; Sweeney and Xu, 2012). The cellulase market itself is expected to grow dramatically when these enzymes were used to hydrolyze pretreated cellulosic materials to sugars which later fermented to commodities such as bioethanol and bio-based products on a large scale (Taha *et al.,* 2016; Mohanty and Abdullahi, 2016; Kang *et al.,* 2014).

The high cost of cellulase production and low yields of cellulase become the major constraints in industrial applications (Prasanna *et al.,* 2016; Lee *et al.,* 2010). Many strategies had been proposed and developed to make it more economic including the use of cheaper substrates such as empty fruit bunch from palm oil (Shahriarinour *et al.,* 2011), wheat bran, sugarcane bagasse (Kilikian *et al.,* 2014), sawdust (Lo *et al.,* 2005); producing cellulases with higher specific activity on solid substrates and producing enzyme preparations with greater stability for specific processes (Zhang *et al.,* 2006). Recent studies have greatly explored the use of lignocellulosic biomass as a substitute substrate for cellulase production replacing the highly cost of commercial cellulosic substrate.

Lignocellulosic biomass can be a very potential substrate for cellulase production because of its abundance, easily obtain and cheaper raw materials. Lignocellulose is the major structural component of all plants consists of lignin, cellulose and hemicellulose (Sanchez, 2009). Lignocelluloses wastes often refer to plant biomass wastes such as agricultural residue and forest wastes (Mohan *et al*., 2012). Pretreatment is required before further use of lignocellulosic biomass to improve the digestibility of the biomass itself for maximum sugars recovery (Maurya *et al*., 2015). Many factors like lignin content, crystallinity of cellulose and particle size limit the degradation of the cellulose present in the lignocellulosic biomass (Mohan *et al*., 2012).

However, the major problem to the effective use of lignocellulosic biomass is due to the complex structure of lignin, cellulose and hemicellulose tangles together blocking deconstruction from microbes and enzymes (Ghorbani *et al*., 2015). Common used pretreatment include physical and chemical pretreatment which relatively high in cost compared to biological pretreatment (Lim and Wang, 2013; Lee *et al*., 2007).

Biological pretreatment of lignocellulosic biomass involved microorganisms that produced ligninase to degrade lignin content, where fungi currently the main ligninase producer (Maurya *et al.*, 2015; Zhou *et al.*, 2015). Recently, the use of lignocellulolytic fungal in lignocellulose degradation are widely explored and studied because of its ability to produce both cellulase and ligninase (Batista-Garcia *et al.*, 2017; Mtui, 2012). In other words, the need of separated pretreatment process can be eliminated if lignocellulolytic fungal were to be used in cellulase production using lignocellulosic biomass as a substrate.

Productions of cellulase were carried out through fermentation and the common technique is submerged fermentation (SmF) by using various microorganisms. However, solid-state fermentation (SSF) has drawn big attention due to its several potential advantages over SmF. SSF can be defined as the growth of microorganisms on moist, water-insoluble solid substrates in the absence or near-absence of free liquid (Soccol *et al.,* 2017; Moo-Young *et al.,* 1983). Gowthaman et al. (2001) pointed out several advantages of SSF including low capital cost, low energy expenditure, low waste water output, less expensive downstream processing and potential higher volumetric productivity.

In this study, rubber wood sawdust was used as an alternative cost-effective substrate in producing cellulase using potential local lignocellulolytic fungi. This research was aimed to improve the production of cellulase using solid-state fermentation of rubber wood sawdust by selected lignocellulolytic fungal strain. The performance of crude cellulase in hydrolyzing the rubber wood sawdust was also investigated. Hence, the specific objectives of this study were:

a. To determine the best lignocellulolytic fungal used for production of cellulase via solid-state fermentation.
b. To optimize the medium formulation and cultural conditions of solid-state fermentation of rubber wood sawdust for cellulase production by the selected lignocellulolytic fungal in shake-flask culture.
c. To identify the function of crude cellulase obtained during solid-state fermentation in enzymatic hydrolysis of rubber wood sawdust.

REFERENCES

Abo-State, M.A.M., Hammad, A.I., Swelim, M., and Gannam, R.B. (2010). Enhanced production of cellulase(s) by *Aspergillus* spp. isolated from agricultural waste by solid state fermentation. *American-Eurasian Journal of Agriculture and Environmental Sciences*, 8(4): 402-410.

Acharya, P.B., Acharya, D.K. and Modi, H.A. (2008). Optimization for cellulase production by *Aspergillus niger* using saw dust as substrate. *African Journal of Biotechnology,* 7(22): 4147-4152.

Adu, S., Adu, G., Frimpong-Mensah, K., Antwi-Boasiako, C., Effah, B., and Adjei, S. (2014). Maximizing wood residue utilization and reducing its production rate to combat climate change. *International Journal of Plant and Forestry Sciences*, 1(2): 1-12.

Adsul, M.G., Bastawde, K.B., Varma, A.J., and Gokhale, D.V. (2007). Strain improvement of *Penicillium janthinellum* NCIM 1171 for increased cellulase production. *Bioresource Technology*, 98: 1467-1473.

Agger, J., Viksø-Nielsen. A. and Meyer, A. S. (2010). Enzymatic xylose release from pretreated corn bran arabinoxylan: differential effects of deacetylation and deferuloylation on insoluble and soluble substrate fractions. *Journal of Agricultural and Food Chemistry*, 58: 6141-6148

Akinyele, J.B., Fabunmi, A.O. and Olaniyi, O.O. (2013). Effect of variations in growth parameters on cellulase activity of *Trichoderma viride* NSPR006 cultured on different wood-dusts. *Malaysian Journal of Microbiology,* 9(3): 193-200.

Alam, M.Z., Mamun, A.A., Qudsieh, I.Y., Muyibi, S.A., Salleh, H.M. and Omar, N.M. (2009). Solid state bioconversion of oil palm empty fruit bunches for cellulase enzyme production using a rotary drum bioreactor. *Biochemical Engineering Journal*, 46: 61-64.

Alam, M.Z., Manchur, M.A. and Anwar, M.N. (2004). Isolation, purification, characterization of cellulolytic enzymes produced by the isolate *Streptomyces omiyaensis*. *Pakistan Journal of Biological Sciences,* 7(10): 1647-1653.

Alhassan, M.A., Kuang, D., Mohammad, A.B. and Sharma-Shivappa, R.R. (2009). Combined effect of nitric acid and sodium hydroxide pretreatments on enzymatic saccharification of rubber wood (*Heaveaa brasiliensis*). *International Journal of Chemical Technology,* 2:12-20.

Amin, F.R., Khalid, H., Zhang, H., Rahman, S.U., Zhang, R., Liu, G. and Chen, C. (2017). Pretreatment methods of lignocellulosic biomass for anaerobic digestion. *AMB Express*, 7:72.

Anbu, P., Gopinath, S.C.B., Chaulagain, B.P., Tang, T.H. and Citartan, M. (2015). Microbial enzymes and their applications in industries and medicine 2014. *BioMed Research International,* 2015:1-3

Ang, S.K., Adibah, Y., Suraini, A.A. and Madihah, M.S. (2015). Potential uses of xylanase-rich lignocellulolytic enzymes cocktail for oil palm trunk (OPT) degradation and lignocellulosic ethanol production. *Energy Fuels*, 29(8): 5103-5116.

Anwar, Z., Gulfraz, M. and Irshad, M. (2014). Agro-industrial lignocellulosic biomass a key to unlock the future bio-energy: a brief review. *Journal of Radiation Research and Applied Sciences,* 7(2014): 163-173.

Arenas, O.R., Huato, M.A.D., Trevino, I.H., Lezama, J.F.C.P., Garcia, A.A and Arellano, A.D.V. (2012). Effect of pH on growth of the mycelium of *Trichoderma viride* and *Pleurotus ostreatus* in solid cultivation mediums. *African Journal of Agricultural Research*, 7(34): 4724-4730.

Avgerinos, G.C. and Wang, D.I. (1983). Selective solvent delignification for fermentation enhancement. *Biotechnology and Bioengineering*, 25(1): 67-83.

Azzaz, H.H., Murad, H.A., Kholif, A.M., Hanfy, M.A. and Gawad, M.H.A. (2012). Optimization of culture conditions affecting fungal cellulase production. *Research Journal of Microbiology,* 7(1): 28-31.

Baadhe, R.R., Potumarthi, R. and Mekala, N.K. (2014). Influence of dilute acid and alkali pretreatment on reducing sugar production from corncobs by crude enzymatic method: A comparative study. *Bioresource Technology*, 162:213-217.

Bagewadi, Z.K., Mulla, S.I. and Ninnekar, H.Z. (2017). Optimization of endoglucanase production from *Trichoderma harzianum* strain HZN11 by central composite design under response surface methodology. *Biomass Conversion and Biorefinery*, https://doi.org/10.1007/s13399-017-0285-3.

Bahrin, E.K. (2012). *Optimization and characterization of oil palm empty fruit bunch fermentation for cellulase prodcution by Botryosphaeria rhodina* UPM3. (PhD Thesis, Universiti Putra Malaysia, Malaysia). Retrieved from http://www.library.upm.edu.my.

Bajpai, P. (2016). Structure of lignocellulosic biomass. *Pretreatment of Lignocellulosic Biomass for Biofuels Production* (pp. 7-12). SpringerBriefs.

Balan, V. (2014). Current challenges in commercially producing biofuels from lignocellulosic biomass. *ISRN Biotechnology,* 2014:1-31.

Balat, M., Balat, H. and Oz, C. (2008). Progress in bioethanol processing. *Progress in Energy and Combustion Science*, 34(5): 551-573.

Barrios-Gonzalez, J. and Tarrago-Castellanos, M.R. (2017). Solid-state fermentation: special physiology of fungi, In Jean-Michel Merillon and Kishan Gopal Ramawat (Eds). *Fungal Metabolites* (pp. 319-347). Springer Internation Publishing.

Batista-Garcia, R.A., Sutton, T., Jackson, S.A., Tovar-Herrera, O.E., Balcazar-Lopez, E., Sanchez-Carbente, M.D.R., Sanchez-Reyes, A., Dobson, A.D.W. and Folch-Mallol, J.L. (2017). Characterization of lignocellulolytic activities from fungi isolated from the deep-sea sponge *Stelleta normani*. *PLoS ONE*, 12(3): 1-30.

Beg, Q.K., Kapoor, M., Mahajan, L. and Hoondal, G.S (2001). Microbial xylanases and their industrial applications: a review. *Applied Microbiology and Biotechnology*, 56: 326 –338

Behera, B.C., Sethi, B.K., Mishra, R.R., Dutta, S.K. and Thatoi, H.N. (2017). Microbial cellulases – diversity & biotechnology with reference to mangrove environment: a review. *Journal of Genetic Engineering and Biotechnology* 15: 197-210.

Behera, S., Arora, R., Nandhagopal, N. and Kumar, S. (2014). Importance of chemical pretreatment for bioconversion of lignocellulosic biomass. *Renewable and Sustainable Energy Reviews*, 36: 91-106.

Behera, S.S. and Ray, R.C. (2016). Solid state fermentation for production of microbial celullases : recent advances and improvement strategies. *International Journal of Biological Macromolecules*, 86: 656-669.

Bhattacharya, S., Das, A., Patnaik, A., Bokade, P. and Rajan, S.S. (2014). Submerged fermentation and characterization of carboxylmethyl cellulase from a rhizospheric isolate *Trichoderma viride* associated with *Azadirachta indica*. *Journal of Scientific & Industrial Research*, 73: 225-230.

Binod, P., Palkhiwala, P., Gaikaiwari, R., Nampoothiri, K.M., Duggal, A., Dey, K. and Pandey, A. (2013). Industrial enzymes – present status and future perspectives for India. *Journal of Scientific & Industrial Research* ,72: 271-286.

Blaszczyk, L., Siwulski, M., Sobieralski, K., Lisiecka, J. and Jedryczka, M. (2014). *Trichoderma* spp. – application and prospects for use in organic farming and industry. *Journal of Plant Protection Research,* 54(4): 309-317.

Brijwani, K., Oberoi, H.S. and Vadlani, P.V. (2010). Production of a cellulolytic enzyme system in mixed-culture solid-state fermentation of soybean hulls supplemented with wheat bran. *Process Biochemistry*, 45: 120-128.

Budihal, S.R. and Agsar, D. (2015). Exploration of agrowastes for the production of cellulase by *Streptomyces* DSK29 under submerged and solid state systems. *International Journal of Current Mircobiology and Applied Sciences,* 4(11): 681-689.

Carasco, M., Villareal, P., Barahona, S., Alcaino, J., Cifuentes, V. and Baeza, M. (2016). Screening and characterization of amylase and cellulase activities in psychrotolerant yeasts. *BioMed Central Microbiology,* 16:21.

Chandel, K., Jandaik, S., Kumari, V., Sarswati, S., Sharma, A., Kumar, D. and Kumar, N. (2013). Isolation, purification and screening of cellulolytic fungi from mushroom compost for production of enzyme (cellulase). *International Journal of Current Research,* 5(1): 222-229.

Chandra, M., Kalra, A., Sharma, P.K., Kumar, H., and Sangwan, R.S. (2010). Optimization of cellulase production by *Trichoderma citrinoviride* on marc of *Artemisia annua* and its application for bioconversion process. *Biomass and Bioenergy*, 34(5): 805-811.

Cheirsilp, B. and Kitcha, S. (2015). Solid state fermentation by cellulolytic oleaginous fungi for direct conversion of lignocellulosic biomass into lipids: fed-batch and repeated-batch fermentations. *Industrial Crops and Products,* 66:73-80.

Chen, H. and Fu, X. (2016). Industrial technologies for bioethanol production from lignocellulosicbiomass. *Renewable Sustainable Energy Reviews*, 57: 468–478.

Chen, Y.W., Tan, T.H., Lee, H.V. and Hamid, S.B.A. (2017). Easy fabrication of highly thermal-stable cellulose nanocrystals using $Cr(NO_3)_3$ catalytic hydrolysis system: a feasibility study from macro- to nano-dimensions. *Materials* 10:42.

Chin, K.L., H'ng, P.S., Wong, L.J., Tey, B.T. and Paridah, M.T. (2017). Optimization study of ethanolic fermentation from oil palm trunk, rubberwood and mixed hardwood hydrolysates using *Saccharomyces cerevisiae*. *Bioresource Technology*, 101(9): 3287-3291.

Christie, S.A.D. and Shanmugam, S. (2012). Analysis of fungal cultures isolate from anamalai hills for laccase enzyme production effect on dye decolorization, antimicrobial activity. *International Journal of Plant, Animal and Environmental Sciences*, 2(3): 143-148.

Cui, L., Mouelhi, F.M., Laframboise, F. and Beauregard, M. (2015). Effect of commercial cellulases and refining on kraft pulp properties: correlation between treatment impacts and enzymatic activity components. *Carbohydrate Polymers* 115(2015): 193-199.

Cunha, F.M., Esperanca, M.N., Zangirolami, T.C., Badino, A.C. and Farinas, C.S. (2012). Sequential solid-state and submerged cultivation of *Aspergillus niger* on sugarcane bagasse for the production of cellulase. *Bioresource Technology* 112(2012): 270-274.

Das, A., Paul, T., Halder, S.K., Maity, C., Mohapatra, P.K.D., Pati, B.R. and Mondal, K.C. (2013). Study on regulation of growth and biosynthesis of cellulolytic enzymes from newly isolated *Aspergillus fumigatus* ABK9. *Polish Journal of Microbiology* 62(1): 31-43.

Dashtban, M., Schraft, H., Syed, T.A. and Qin, W. (2010). Fungal biodegradation and enzymatic modification of lignin. *International Journal of Biochemical and Molecular Biology*, 1(1): 36-50.

Deswal, D., Khasa, Y.P. and Kuhad, R.C. (2011). Optimization of cellulase production by a brown rot fungus *Fomitopsis* sp. RCK2010 under solid state fermentation. *Journal of Bioresource Technology,* 102: 6065-6072.

Devi, R. and Shankar, S. (2008). Bioconversion of cellulose into fermentable sugars by Saccharomyces cerevisiae cells for the production of ethanol using cellulolytic fungi isolated from soil. *The Internet Journal of Microbiology*, 7(2): 1-4.

Dhabhai, R., Jain, A. and Chaurasia, S.P. (2012). Production of fermentable sugars by dilute acid pretreatment and enzymatic saccharification of three different lignocellulosic materials. *International Journal of ChemTech Research*, 4(4): 1497-1502.

Domingues, F.C., Queiroz, J.A., Cabral, J.M.S. and Fonseca, L.P. (2000). The influence of culture conditions on mycelial structure and cellulase production by *Trichoderma reesei* Rut C-30. *Enzyme and Microbial Technology*, 26: 394-401.

Dos Santos, T.C., Filho, G.A., Brito, A.R.D., Pires, A.J.V., Bonomo, R.C.F. and Franco, M. (2016). Production and characterization of cellulolytic enzymes by *Aspergillus niger* and *Rhizopus* sp. by solid state fermentation of prickly pear. *Revista Caatinga*, 29(1): 222-233.

Duff, S., Cooper, D.G. and Fuller, O.M. (1987). Effect of media composition and growth conditions on production of cellulase and β-glucosidase by a mixed fungal fermentation. *Journal of Enzyme Microbial Technology,* 9: 47-52.

Ehrman, T. (1994). Standard method for determination of total solids in biomass. *Laboratory Analytical Procedure,* In: Laboratory Analytical Procedures No. 001. National Renewable Energy Laboratory. Golden, CO.

El-Hadi, A.A., El-Nour, S.A., Hammad, A., Kamel, Z., and Anwar, M. (2014). Optimization of cutural and nutritional conditions for carboxylmethylcellulase production by *Aspergillus hortai*. *Journal of Radiation Research and Applied Sciences,* 7: 23-28.

Elsharkawy, M.M., Shimizu, M., Takahashi, H. and Hyakumachi, M. (2012). The plant growth-promoting fungus *Fusarium equiseti* and the arbuscular mycorrhizal fungus *Glomuss mosseae* induce systemic resistance against *cucumber mosaic virus* in cucumber plants. *Plant and Soil*, 361(1): 397-409.

Farinas, C.S. (2015). Developments in solid-state fermentation for the production of biomass-degrading enzymes for the bioenergy sector. *Renewable and Sustainable Energy Reviews* 52(2015): 179-188.

Farouq, A.A. (2012). *Bioethanol production using lignocellulosic biomass hydrolysate from indigenous fungi fermentation* (PhD tesis, Universiti Putra Malaysia, Malaysia). Retrieved from http://www.library.upm.edu.my.

Fawzi, E.M. (2003). Production and purification of β-glucosidase and protease by *Fusariumproliferatum* NRRL 26517 grown on *Ficus nitida* wastes. *Annals of Microbiology*, 53(4): 463-476.

Fernandes, E.M., Pires, R.A., Mano, J.F. and Reis, R.L. (2013). Bionanocomposites from lignocellulosic resources: properties, applications and future trends for their use in the biomedical field. *Progress in Polymer Science* 38(2013): 1415-1441.

Ferreira, J.A., Mahboubi, A., Lennartsson, P.R. and Taherzadeh, M.J. (2016). Waste biorefineries using filamentous ascomycetes fungi: Present status and future prospects. *Bioresources Technology*, 215: 334-345.

Galbe, M. and Zacchi, G. (2012). Pretreatment: The key to efficient utilization of lignocellulosic materials. *Biomass and Bioenergy*, 46: 70-78.

Gams, W. and Bissett J. (1998) Morphology and identification of *Trichoderma*. In: Harmann GE, Kubicek CP, editors. *Trichoderma* and *Gliocladium*. London: Taylor and Francis; pp. 3–34.

Gao, Z., Hop, D.V., Yen, L.T.H., Ando, K., Hiyamuta, S. and Kondo, R. (2012). The production of β-glucosidase by *Fusarium proliferatum* NBRC109045 isolated form Viatnamese forest. *AMB Express*, 2: 49.

Gao, Z., Mori, T. and Kondo, R. (2012). The pretreatment of corn stover with *Gloeophyllum trabeum* KU-41 for enzymatic hydrolsis. *Biotechnology for Biofuels*, 5(1): 28.

Gaur, R. and Tiwari, S. (2015). Isolation, production, purification and characterization of an organic-solvent-thermostable alkalophilic cellulase from *Bacillus vallismortis* RG-07. *BioMed Central Biotechnology* 15:19

Gautam, S.P., Bundela, P.S., Pandey, A.K., Khan, J., Awasthi, M.K., and Sarsaiya, S. (2011). Optimization for the production of cellulase enzyme from municipal solid waste residue by two novel lignocellulolytic fungi. *Biotechnology Research International*. 2011: 1-8.

George, S. P., Ahmad, A. and Rao, M. B. (2001). Studies on carboxymethyl cellulase produced by an alkalothermophilic actinomycete. *Bioresource Technology*, 77,:171–175.

Ghorbani, F., Karimi, M., Biria, D., Kariminia, H.R. and Jeihanipour, A. (2015). Enhancement of fungal delignification of rice straw by *Trichoderma viride* sp. to improve its saccharification. *Biochemical Engineering Journal*, 101: 77-84.

Gomathi, D., Muthulakshmi, D., Kumar, D.G., Ravikumar, G., Kalaiselvi, M. and Uma, C. (2012). Submerged fermentation of wheat bran by *Aspergillus flavus* for production and characterization of carboxyl methyl cellulase. *Asian Pacific Journal of Tropical Biomedicine*, S67-S73.

Gowthaman, M.K., Krishna, C. and Young, M.M. (2001). Fungal solid state fermentation – an overview. *Applied Mycology and Biotechnology*, 1: 305-352.

Grujic, M., Dojnov, B., Potocnik, I., Duduk, B. and Vujcic, Z. (2015). Spent mushroom compost as substrate for the production of industrially important hydrolytic enzymes by fungi *Trichoderma* spp. *Aspergillus niger* in solid state fermentation. *International Biodeterioration & Biodegradation*. 104: 290-298.

Gunny, A.A.N., Arbain, D., Jamal, P. and Gumba, R.E. (2015). Improvement of halophilic cellulase production from locally isolated fungal strain. *Saudi Journal of Biological Science*. 22: 476-483.

Gusakov, A.V. (2011). Alternatives to *Trichoderma reesei* in biofuel production. *Trends in Biotechnology*, 29(9): 419-425.

Hansen, G.H.., Lubeck, M, Frisvad, J.C., Lubeck, P.S. and Andersen, B. (2015). Production of cellulolytic enzymes from ascomycetes: comparison of solid state and submerged fermentation. *Process Biochemistry*. 50: 1327-1341.

Hariharan, S. and Nambisan, P. (2013). Optimization of lignin peroxidase, manganese peroxidase, and lac production from *Ganoderma lucidum* under solid state fermentation of pineappple leaf. *BioResource*, 8(1): 250-271.

Hendriks, A.T.W.M. and Zeeman, G. (2009). Pretreatments to enhance the digestibility of lignocellulolytic biomass. *Bioresource Technology* 100: 10-18.

Horinouchi, H., Muslim, A., Suzuki, T. and Hyakumachi, M. (2007). *Fusarium equiseti* GF191 as an effective biocontrol agent against *Fusarium* crown and root rot of tomato in rock wool systems. *Crop Protection*, 26(10): 1514-1523.

Horn, S.J., Vaaje-Kolstad, G., Westereng, B. and Eijsink, V.G.H. (2012). Novel enzymes for the degradation of cellulose. *Biotechnology for Biofuels* 5:45.

Hussain, A., Shrivastav, A., Jain, S.K., Baghel, R.K., Rani, S. and Agrawal, M.K. (2012). Cellulolytic enzymatic activity of soft rot filamentous fungi *Paecilomyces variotii*. *Advances in Bioresearch* 3(3): 10-17.

Ibrahim, D., Puspitaloka, H., Rahim, A.R. and Hong, L.S. (2012). Characterization of solid state fermentation culture conditions for growth and mananase production by *Aspergillus niger* USM F4 on rice husk in tray system. *British Biotechnology Journal* 2(3): 133-145.

Idris, A.S.O., Pandey, A., Rao, S.S. and Sukumaran, R.K. (2017). Cellulase production through solid-state tray fermentation, and its use for bioethanol from sorghum stover. *Bioresource Technology*, 242: 265-271.

Imran, M., Anwar, Z., Irshad, M., Asad, M.J. and Ashfaq, H. (2016). Cellulase production from species of fungi and bacteria from agricultural wastes and its utilization in industry: a review. *Advance in Enzyme Research*, 4: 44-55.

Iqbal, H.M.N., Asgher, M., Ahmed, I. and Hussain, S. (2010). Media optimization for hyper-production of carboxylmethyl cellulase using proximally analyzed agro-industrial residue with *Trichoderma harzianum* under SSF. *International Journal of Agro Veterinary and Medical Sciences*, 4(2): 27-55.

Islam, R., Sparling, R., Cicek, N. and Levin, D.B. (2015). Optimization of influential nutrients during direct cellulose fermentation into hydrogen by *Clostridium thermocellum*. *International Journal of Molecular Sciences* 16: 3116-3132.

Ja'afaru, M.I. (2013). Screening of fungi isolated from environmental samples for xylanase and cellulase production. *ISRN Microbiology* 2013:1-7.

Jaber, S.M., Md. Shah, U.K., Mohamed As'ari, A.Z. and Ariff, A.B. (2017). Optimization of laccase production by locally isolated *Trichoderma muroiana* IS1037 using rubber wood dust as substrate. *BioResources*, 12(2): 3834-3849.

Jadhav, A.R, Girde, A.V, More, S.M, More, S.B, and Khan S. (2013). Cellulase production by utilizing agricultural wastes. *Research Journal of Agriculture and Forestry Sciences*, 1(7): 6-9.

Jain, P. and Jain, K. (2016). Enhanced cellulase production from isolated fungus *Aspergillus niger* RKJP and its application in lignocellulosic saccharification for bioethanol production. *Biotechnological Research* 2(2): 61-68.

Jamal, P., Tijani, R.I.D., Alam, M.Z. and Mirghani, M.E.S. (2012). Effect of operational parameters on solid state fermentation of cassava peel to an enriched animal feed. *Journal of Applied Sciences,* 12: 1166-1170.

Jarvinen, J., Taskila, S., Isomaki, R. and Ojama, H. (2012). Screening of white-rot fungi manganese peroxidase: a comparison between the specific activities of the enzyme from different native producers. *AMB Express,* 2(62).

Juhasz, T., Szengyel, Z., Reczey, K., Siika-Aho, M. and Viikari, L. (2005). Characterization of cellulases and hemicellulases produced by *Trichoderma reesei* on various carbon sources. *Process Biochemistry,* 40: 3519-3525.

Jung, D.U., Yoo, H.Y., Kim, S.B., Lee, J.H., Park, C. and Kim, S.W. (2015). Optimization of medium composition for enhanced cellulase production by mutant *Penicillium brasilianum* KUEB15 using statistical method. *Journal of Industrial and Engineering Chemistry,* 25: 145-150.

Kang, Q., Appels, L., Tan, T. and Dewil, R. (2014). Bioethanol from lignocellulosic biomass: current findings determine research priorities. *The Scientific World Journal*, 2014: 1-13.

Kaseke, Z.M., Okaiyeto, K., Nwondo, U.U., Mabinya, L.V. and Okoh, A.I. (2016). Optimization of cellulas and xylanase production by *Micrococcus* species under submerged fermentation. *Sustainability*, 8: 1168.

Kashem, M.A., Manchur, M.A., Rahman, M.S. and Anwar, M.N. (2004). Effect of carbon and nitrogen sources on the production of reducing sugars, extra-cellular protein and cellulolytic enzymes by two cellulolytic bacterial isolates. *Pakistan Journal of Biological Sciences* 7(10): 1660-1663.

Khan, M.N., Luna, I.Z., Islam, M.M., Sharmeen, S., Saleem, K.S., Rashid, T.U., Zaman, A., Haque, P. and Rahman, M.M. (2016). Cellulase in waste management applications. *New and Future Development in Microbial Biotechnology and Bioengineering* (pp. 237-256). Elsevier.

Kilikian, B.V., Afonso, L.C., Souza, T.F.C., Ferreira, R.G. and Pinheiro, I.R. (2014). Filamentous fungi and media for cellulase production in solid state cultures. *Brazilian Journal of Microbiology* 45(1): 279-286.

Kim, C.H., Kim, J.N., Ha, J.K., Yun, S.G. and Lee, S.S. (2004). Effects of dietary addition of surfactant tween 80 on ruminal fermentation and nutrient digestibility of hanwoo steers. *Asian-Australian Journal of Animal Sciences,* 17(3): 337-342.

Kooopmans, A. and Koppejan, J. (1997). Agricultural and forest residues – generation, utilization and availability. Paper presented at the Regional Consultation on Modern Applications of Biomass Energy, Kuala Lumpur. January 1997.

Koshy, J. and Nambisan, P. (2012). Pretreatment of agricultural waste with *Pleurotus sp*. for ethanol production. *International Journal of Plant, Animal and Enviromental Sciences*, 2(2): 244-249.

Kuhad, R. C., Deswal, D., Sharma, S., Bhattacharya, A., Jain, K.K., Kaur, A., et al. (2016). Revisiting cellulase production and redefining current strategies based on major challenges. *Renewable and Sustainable Energy Reviews*, *55*, 249-272.

Kuhad, R.K., Gupta, R. and Singh, A. (2011). Microbial cellulases and their industrial applications. *Enzyme Research* 2011:1-10.

Kuhad, R.C., Mehta, G., Gupta, R., Sharma K. K., (2010). Fed batch enzymatic saccharification of newspaper cellulosics improves the sugar content in the hydrolysates and eventually the ethanol fermentation by *Saccharomyces cerevisiae*. *Biomass Bioenergy*. 34: 1189-1194.

Kumar, A., Dutt, D. and Gautam, A. (2016). Production of crude enzyme from *Aspergillus nidulans* AKB-25 using black gram residue as the substrate and its industrial applications. *Journal of Genetic Engineering and Biotechnology* 14: 107-118.

Kumar, A.K. and Sharma, S. (2017). Recent updates on differnet methods of pretreatment of lignocellulosic feedstocks: a review. *Bioresources and Bioprocessing,* 4(1):7.

Kumar, L., Arantes, V., Chandra, R. and Saddler, J. (2012). The lignin present in steam pretreated softwood binds enzymes and limits cellulose accessibility. *Bioresource Technology*, 103: 201-208.

Kumar, R., Singh, S. and Singh, O.V. (2008). Bioconversion of lignocellulosic biomass: biochemical and molecular perspective. *Journal of Industrial Microbiology & Biotechnology*, 35(5): 377-391.

Kwon, H.W., Yoon, J.H., Kim, S.H., Hong, S.B., Cheon, Y. and Ko, S.J. (2007). Detection of extracellular enzymes activities in various *Fusarium spp*. *Mycobiology*, 35(3): 162-165.

Ladeira, S.A., Cruz, E., Delatorre, A.B., Barbosa, J.B. and Martins, M.L.L. (2015). Cellulase production by thermophilic *Bacillus* sp. SMIA-2 and its detergent compatibility. *Electronic Journal of Biotechnology* 18(2015): 110-115.

Latifian, M., Esfahani, Z.H. and Barzegar, M. (2007). Evaluations of culture conditions for cellulase production by two *Trichoderma reesei* mutants under solid-state fermentation conditions. *Bioresources Technology*, 3634-3637.

Lee, B.H., Kim, B.K., Lee, Y.J., Chung, C.H. and Lee, J.W. (2010). Industrial scale of optimization for the production of carboxylmethylcellulase from rice bran by a marine bacterium, *Bacillus subtilis subsp. subtilis* A-53. *Enzyme Microbial Technology*, 46(1): 38-42.

Lee, J.W., Gwak, K.S., Park, J.Y., Park, M.J., Choi, D.H., Kwon, M. and Choi, I.G. (2007). Biological pretreatment of softwood *Pinus densiflora* by three white rot fungi. *The Journal of Microbiology*, 45(6): 485-491.

Lee, S.S. and Ha, J.K. (2003). Influences of surfactant Tween 80 on the gas production, cellulase digestion and enzyme activities by mixed rumen microorganisms. *Australian Jurnal of Animal Science*, 16(8): 1151-1157.

Li, C., Yang, Z., Zhang, R.H.C., Zhang, D., Chen, S. and Ma, L. (2013). Effect of pH on cellulase production and morphology of *Trichoderma ressei* and the application in cellulosic material hydrolysis. *Journal of Biotechnology*, 168: 470-477.

Li, Y. and Wan, C. (2012). Fungal pretreatment of lignocellulosic biomass. *Biotechnology Advances*, 30: 1447-1457.

Lim, J.W. and Wang, J.Y. (2013). Enhanced hydrolysis and methane yield by applying microaeration pretreatment to the anaerobic co-digestion of brown water and food waste. *Waste Management*, 33: 813–819.

Liu, D., Zhang, R., Yang, X., Zhang, Z., Song, S., Miao, Y. And Shen, Q. (2012). Characterization of a thermostable β-glucosidase from Aspergillus fumigatus Z5, and its functional expression in *Pichia pastoris* X33. *Microbial Cell Factories*, 11:25.

Llano, T., Garcia-Quevedo, N., Quijorna, N., Viguri, J.R. and Coz, A. (2015). Evolution of lignocellulosic macrocomponents in the wastewater streams of a sulfite pulp mill: a preliminary biorefining approach. *Journal of Chemistry* 2015:1-10.

Lo, C.H., Zhang, Q., Lee, P. and Ju, L.K. (2005). Cellulase production by Trichoderma reesei using sawdust hydrolysate. *Applied Biochemistry and Biotechnology* 121-124: 561-574.

Long, K. and Knapp, J.S. (1991). The effect of junlon PW110 and tween 80 on the production of cellulolytic enzymes by *Coprinus cinereus*. *Mycological Research,* 95(9): 1077-1081.

Lu, H., Zhang, X., Wu, A., Deng, X., Ren, J., Kong, F. and Li, H. (2017). Comparison of dilute acid, alkali, and biological pretreatment for reducing sugar production from Eucalyptus. *BioResources*, 12(3): 6353-6365.

Lugani, Y., Singla, R. and Sooch, B.S. (2015). Optimization of cellulase production from newly isolated *Bacillus* sp. Y3. *Bioprocessing & Biotechniques* 5(11): 1-6.

Lynd, L.R., Weimer, P.J., van Zyl, W.H. and Pretorius, I.S. (2002). Microbial cellulose utilization: fundamentals and biotechnology. *Microbiology and Molecular Biology Reviews*, 66(3):506–577

Ma, K. and Ruan, Z. (2015). Production of lignocellulolytic enzyme system for simultaneous bio-delignification and saccharification of corn stover employing co-culture of fungi. *Bioresource Technology* 175(2015): 586-593.

Maciel, M.J.M., Silva, A.C. and Ribeiro, H.C.T. (2010). Industrial and biotechnological application of ligninolytic enzymes of the basidiomycota : a review. *Electronic Journal of Biotechnology*, 13(6).

Madhu, A. and Chakraborty, J.N. (2017). Developments in application of enzymes for textile processing. *Journal of Clear Production* 146(2017): 114-133.

Makela, M.R., Donofrio, N. and de Vries, R.P. (2014). Plant biomass degradation by fungi. *Fungal Genetics and Biology*, 72: 2-9.

Maleki, S.S., Mohammadi, K. and Ji, K.S. (2016). Characterization of cellulose synthesis in plant cells. *The Scientific World Journal*, 2016: 1-8.

Mandels, M., Hontz, I. and Nystrom, J. (1974). Enzymatic hydrolysis of waste cellulose. *Biotechnology and Bioengineering*, 16: 1471-1493

Mangalanayaki, R. and Madhavan, S. (2015). Cellulase production by *Trichoderma harzianum* and *Fusarium oxysporum* under solid state fermentation. *World Journal of Pharmacy and Pharmaceutical Sciences* 4(11): 1822-1828.

Manhar, A.K., Bashir, Y., Saikia, D., Nath, D., Gupta, K., Konwar, B.K., Kumar, R., Namsa, N.D. and Mandal, M. (2016). Cellulolytic potential of probiotic *Bacillus subtilis* AMS6 isolated from traditional fermented soybean (Churpi): an in-vitro study with regards to application as an animal feed additive. *Microbiology Research* 62-70: 186-187.

Mansfield, S.D. ,Wong, K.K.Y., De Jong, E. and Saddler, J.N. (1996). Modification of Douglas-fir mechanical and kraft pulps by enzyme treatment. *Tappi Journal*, 79(8): 125–132.

Marriott, P.E., Gomez, L.D. and McQueen-Mason, S.J. (2015). Unlocking the potential of lignocellulosic biomass through plant science. *New Phytologist*, 209(4): 1366-1381.

Mathew, G.M., Sukumaran, R.K., Singhania, R.R. and Pandey, A. (2008). Progress in research on fungal cellulases for lignocellulose degradation. *Journal of Scientific and Industrial ResearchIndia*, 67(11): 898-907.

Matsakas, L., Gao, Q., Jansson, S., Rova, U. and Christakopoulos, P. (2017). Green conversion of municipal solid wastes into fuels and chemicals. *Electronic Journal of Biotechnology*, 26: 69-83.

Maurya, D.P., Singla, A. and Negi, S. (2015). An overview of key pretreatment processes for biological conversion of lignocellulosic biomass to bioethanol. *3 Biotech*, 5: 597-609.

Membrillo, I., Sanchez, C., Meneses, M., Favela, E. and Loera, O. (2008). Effect of substrate particle size and additional nitrogen source on production of lignocellulolytic enzymes by *Pleurotus ostreatus* strains. *Bioresource Technology*, 99(16): 7842–7847.

Mendes, F.B., Atala, D.I.P. and Thomeo, J.C. (2017). Is cellulase production by solid-state fermentation economically attractive for the second generation ethanol production?. *Renewable Energy*, 114: 525-533.

Menon, V. and Rao, M. (2012). Trends in bioconversion of lignocellulose: Biofuels, platform chemicals & biorefinery concepts. *Process in Energy and Combustion Sciences*, 38: 522-550.

Miller, G.L. (1959). Use of dinitrosalicyclic acid reagent for determination of reducing sugar. *Analytical Chemistry,* 31(3): 426-428.

Mishra, P.K. and Khan, F.N. (2015). Effect of different growth media and physical factors on biomass production of *Trichoderma viride*. *People's Journal of Scientific Research*, 8(2): 11-16.

Modenbach, A.A. and Nokes, S.E. (2013). Enzymatic hydrolysis of biomass at high-solids loadings - A review. *Biomass and Bioenergy*, 56: 526-544.

Mohan, P.R., Ramesh, B. and Reddy, O.V.S. (2012). Production and optimization of ethanol from pretreated sugarcane bagasse using *Saccharomyces bayanus* in simultaneous saccharification and fermentation. *Microbiology Journal*, 2(2): 52-63.

Mohanty, B. and Abdullahi, I.I. (2016). Bioethanol production from lignocellulosic waste-a review. *Biosciences Biotechnology Research* 13(2): 1153-1161.

Mohapatra, B.R., Bapuji, M. and Sree, A. (2003). Production of industrial enzymes (amylase, carboxymethylcellulase and protease) by bacteria isolated from marine sedentary organisms. *Acta Biotechnologica*, 23(1): 75-84.

Moo-Young, M., Moriera, A. R., Tengerdy, R. P. (1983). Principles of solid state fermentation. In *Smith J. E, Berry D. R., Kristiansen B.* (Eds.), *The filamentous fungi: Vol. 4. Fungal Technology* (pp. 117–144). Edward Arnold Publishers.

Mou, H.Y., Wu, S. and Fardim, P. (2016). Applications of ToF-SIMS in surface chemistryanalysis of lignocellulosic biomass: a review. *BioResources,* 11: 5581–5599.

Mtui, G.Y.S. (2012). Lignocellulolytic enzymes from tropical fungi: types, substrates and applications. *Scientific Research and Essays*, 7(15): 1544-1555.

Mukhopadhyay, S. and Nandi, B. (1999). Optimization of cellulase production by *Trichoderma reesei* ATCC 26921 using a simplified medium on water hyacinth biomass. *Journal of Scientific and Industrial Research*, 58: 107-111.

Murad, H.A. and Azzaz, H.H. (2010). Cellulase and dairy animal feeding. *Biotechnology*, 9(3): 238-256.

Murphy, L., Bohlin, C., Baumann, M.J., Olsen, S.N., Sorensen, T.H., Anderson, L., Borch, K. and Westh, P. (2013). Product inhibition of five *Hypocrea jecorina* cellulases. *Enzyme and Microbial Technology*, 57: 163-169.

Muthuvelayudham, R. and Viruthagiri, T. (2006). Fermentative production and kinetics of cellulase protein on *Trichoderma reesei* using sugarcane bagasse and wheat straw. *African Journal of Biotechnology*, 5(20): 1873-1881.

Nadagouda, M.G., Lingappa, K., Bheemareddy, V.S. and Malipatil, S.G. (2016). Optimization of solid state fermentation conditions for the production of cellulase by using *Trichoderma viride* GSG12. *Bioscience Discovery* 7(1):01-06.

Narasimha, G., Sridevi, A., Viswanath, B., Chandra, M.S. and Reddy, B.R. (2006). Nutrient effects on production of cellulolytic enzymes by *Aspergillus niger*. *African Journal of Biotechnology* 5(5): 472-476.

Nathan, V.K., Rani, M.E., Rathinasamy, G., Dhiraviam, K.M. and Jayavel, S. (2014). Process optimization and production kinetics for cellulase production by *Trichoderma viride* VKF3. *SpringerPlus,* 3: 92.

Nazarpour, F., Abdullah, D.K., Abdullah, N., Motedayen, N. and Zamiri, R. (2013). Biological pretreatment of rubberwood with *Ceriporiopsis subvermisfora* for enzymatic hydrolysis and bioethanol production. *BioMed Research International*, 2013: 1-9.

Ng, I.S., Wu, X., Lu, Y. and Yao, C. (2014). *Trichoderma reesei* cellulase complex in hydrolysis of agricultural waste of grapefruit peel and orange peel. *BioResources*, 9(4): 6420-6431.

Nkohla, A., Okaiyeto, K., Olaniran, A., Nwodo, U., Mabinya, L. and Okoh, A. (2017). Optimization of growth parameters for cellulase and xylanase production by *Bacillus* species isolated from decaying biomass. *Journal of Biotechnology Research*, 8: 33-47.

Obruca, S., Marova, I., Matouskova, P., Haronikova, A. and Lichnova, A. (2012). Production of lignocellulose-degrading enzymes employing *Fusarium solani* F-552. *Folia microbilogica*, 57(3): 221-227.

Öhgren, K., Bura, R., Saddler, J. and Zacchi, G. (2007). Effect of hemicellulose and lignin removal on enzymatic hydrolysis of steam pretreated corn stover. *Bioresource Technology*, 98(13): 2503–2510.

Ogbonna, A.I, Onwuliri, F.C, Ogbonna, C.I.C. and Oteikwu, J.E. (2015). Optimization of cellulase production and biodegradation of *Artemisia annua*. L. wastes by *Aspergillus niger* and *Trichoderma viride*. J*ournal of Academia and Industrial Research,* 3(12): 598-602.

Olajuyigbe, F.M., Nlekerem, C.M. and Ogunyewo, O.A. (2016). Production and characterization of highly thermostable β-glucosidase during the biodegradation of methyl cellulose by *Fusarium oxysporum*. *Biochemistry Research International* 2016:1-8.

Omojasola, P.F., Jilani, O.P. and Ibiyemi, S.A. (2008). Cellulase production by some fungi cultured on pineapple waste. *Nature and Science*, 6(2): 64-79.

Osman, N.B., Othman, H.T., Karim, R.A. and Mazlan, M.A.F. (2014). Biomass in Malaysia: forestry-based residues. *International Journal of Biomass & Renewables*, 3(1): 7-14.

Pandey, A. (2003). Solid-state fermentation. *Biochemical Engineering Journal*, 13(2-3): 81-84.

Pandey, A. (1991). Effect of particle size of substrate on enzyme production in solid state fermentation. *Bioresources Technology*, 37: 169-172.

Pandey, S., Srivastava, M., Shahid, M., Kumar, V., Singh, A., Trivedi, S. and Srivastava, Y.K. (2015). *Trichoderma* species cellulases produced by solid state fermentation. Journal of Data Mining *Genomics Proteomics,* 6(2): 170-174.

Pandit, N.P. and Maheshwari, S.K. (2012). Optimization of cellulase enzyme production from sugarcane pressmud using oyster mushroom – *Pleurotus Sajor-Caju* by solid state fermentation. *Bioremediation & Biodegradation* 3(3): 1-5.

Papagianni, M. (2004). Fungal morphology and metabolite production in submerged mycelial processes. *Biotechnology Advances*, 22: 189-259.

Pointing, S.B. (1999). Qualitative methods for the determination of lignocellulolytic enzyme production by tropical fungi. *Fungal Diversity* 2: 17-33.

Pollegioni, L., Tonin, F. and Rosini, E. (2015). Lignin-degrading enzymes. The *Federation of European Biochemical Societies Journal* 282(7): 1190-1213.

Prakasham, R.S, Rao, C.S, Rao, R.S. and Sarma, P.N. (2007). Enhancement of acid amylase production by an isolated *Aspergillus awamori*. *Journal of Applied Microbiology* 102(1): 204-211.

Prasanna, H.N., Ramanjaneyulu, G. and Reddy, B.R. (2016). Optimization of cellulase production by *Penicillium* sp. *3 Biotech* 6:162.

Quintero-Ramirez, R. (2014). Hydrolysis of lignocellulosic biomass. In Luis Augusto Barbos (Coord.), Sugarcane Bioethanol – R&D for Productivity and Sustainability (pp. 717-732). Blucher.

Raghuwanshi, S., Deswal, D., Karp, Matti. and Kuhad, R.C. (2014). Bioprocessing of enhanced cellulase production from a mutant of *Trichoderma asperellum* RCK2011 and its application in hydrolysis of cellulose. *Fuel*, 124: 183-189.

Rai, D. and Tewari, A.K. (2016). Evaluation of different carbon and nitrogen sources for better growth and sporulation of *T. harzianum* (Th14). *Journal of Agricultural Biotechnology and Sustainable Development* 8(8): 67-70.

Rai, P., Tiwari, S. and Gaur, R. (2012). Optimization of process parameters for cellulase production by novel thermotolerant yeast. *BioResources* 7(4): 5401-5414.

Raimbault, M. (1998). General and microbiological aspects of solid substrate fermentation. *Electonic Journal of Biotechnology*, 1: 174-188.

Rajesh, M.J., Rajesh, L. and Abachire, L.W. (2012). Optimization of solid state fermentation conditions for the production of cellulase by *Trichoderma reesei*. E*uropean Journal of Applied Engineering and Scientific Research,* 1(4): 196-200.

Rajoka, M.I. and Malik, K.A. (1997). Cellulase production by *Cellulomonas biozotea* cultured in media containing different cellulosic substrates. *Bioresource Technology*, 59(1): 21-27.

Ramachandran, S., Patel, A.K., Nampoothiri, K.M., Francis, F., Nagy, V., Szakacs, G. and Pandey, A. (2004). Coconut oil cake—a potential raw material for the production of amylase. *Bioresource Technology*, 93: 169–174.

Ramanathan, G., Banupriya, S. and Abirami, D. (2010). Production and optimization of cellulase from *Fusarium oxysporum* by submerged fermentation. *Journal of Scientific & Industrial Research* 69: 454-459.

Rasul, F., Afroz, A., Rashid, U., Mehmood, S., Sughra, K. and Zeeshan N. (2015). Screening and characterization of cellulase producing bacteria from soil and waste (molasses) of sugar industry. *International Journal of Biosciences* 6(3): 230-238.

Ratnasingam, J., Ramasamy, G., Wai, L.T., Senim, A.L. and Muttiah, N. (2015). The prospects of rubberwood biomass energy production in Malaysia. *Bioresources* 10(2): 2526-2548.

Ratnasingam, J., Ramasamy, G., Ioras, F., Kaner, J. and Wenming, L. (2012). Production potential of rubberwood in Malaysia: its economic challenges. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* 40(2): 317-322.

Ratnasingam, J. and Jones, M.L. (2011). Recovery problems in rubberwood plantations. IFRG Report No. 14, Kuala Lumpur, p. 47.

Reanprayoon, P. and Pathomsiriwong, W. (2012). Tropical soil fungi producing cellulase and related enzymes in biodegradation. *Journal of Applied Sciences* 12(18): 1909-1916.

Reddy, G.P.K., Naramsinha, G., Kumar, K.D., Ramanjaneyulu, G., Ramya, A., Kumari, B.S.S. and Reddy, B.R. (2015). Cellulase production by *Aspergillus niger* on different natural lignocellulosic substrates. *International Journal of Current Mircobiology and Applied Sciences* 4(4): 835-845.

Reese, E.T., and Maguire, A. (1969).Surfactants as stimulants of enzyme production by microorganisms. *Applied Microbiology* 17: 242-245.

Rosyida, V.T., Indrianingsih, A.W., Maryana, R. and Wahono, S.K. (2015). Effect of temperature and fermentation time of crude cellulase production by *Trichoderma reesei* on straw substrate. *Energy Procedia,* 65: 368-371.

Saini, A., Aggarwal, N.K. and Yadav, A. (2017). Cost-effective cellulase production using *Parthenium hysterophorus* biomass as an unconventional lignocellulosic substrate. *3 Biotech*, 7:12.

Saini, R., Saini, J.K., Adsul, M., Patel, A.K., Mathur, A., Tuli, D. and Singhania, R.R. (2015). Enhanced cellulase production by *Penicilllium oxalicum* for bio-ethanol application. *Bioresource Technology* 188(2015): 240-246.

Sajith, S., Priji, P., Sreedevi, S. and Benjamin, S. (2016). An overview on fungal cellulases with an industrial perspective. *Journal Nutrition & Food Science* 6:1.

Sanchez, C. (2009). Lignocellulosic residues: biodegradation and bioconversion by fungi. *Biotechnology Advances*, 27(2): 185-194.

Sara, S. and Raj, B. (2011). Ethanol production from lignocellulosic biomass of energy cane. *International Biodeterioration & Biodegradation*, 65(1): 142-146.

Saritha, M., Arora, A. and Lata. (2012). Biological pretreatment of lignocellulosic substrates for enhanced delignification and enzymatic digestibility. *Indian Journal of Microbiology*, 52(2): 122-130.

Sarkar, N. and Aikat, K. (2012). Cellulase and xylanase production from rice straw by a locally isolated fungus *Aspergillus fumigatus* NITDGPKA3 under solid state fermentation – statistical optimization by response surface methodology. *Journal of Technology Innovations in Renewable Energy* 1(2012): 54-62.

Saxena, S. (2015). Microbial enzymes and their industrial applications. *Applied Microbiology* (pp. 121-154). Springer, New Delhi.

Sethi, S., Datta, A., Gupta, B.L. and Gupta, S. (2013). Optimization of cellulase production from bacteria isolated from soil. *ISRN Biotechnology* 2013: 1-7.

Sewalt, V.J.H., Glasser, W.G. and Beauchemin, K.A. (1997). Lignin impact on fiber degradation. 3. Reversal of inhibition of enzymatic hydrolysis by chemical modification of lignin and additives. *Journal of Agricultural and Food Chemistry*, 45(5): 1823-1828.

Shaaban, A., Se, S.M., Mitan, N.M.M. and Dimin M.F. (2013). Characterization of biochar derived from rubber wood sawdust through slow pyrolysis on surface porosities and functional groups. *Procedia Engineering* 68(2013): 365-371.

Shafique, S., Bajwa, R. and Shafique, S. (2009). Cellulase biosynthesis by selected *Trichoderma* species. *Pakistan Journal of Botany*. 41(2): 907-916.

Shah, S.P., Kalia, K.S. and Patel, J.S. (2015). Optimization of cellulase production by *Penicillium oxalicum* using banana agrowaste as a substrate. *Journal of General Applied Microbiology* 61: 35-43.

Shahriarinour, M., Wahab, M.N.A., Mohamad, R., Mustafa, S. and Ariff, A.B. (2011). Effect of medium composition and cultural condition on cellulase production by *Aspergillus tereus*. *African Journal of Biotechnology*, 10(38): 7459-7467.

Shahsavarani, H., Hasegawa, D., Yokota, D., Sugiyama, M., KaneKo, Y., Boonchird, C. and Marashima, S. (2013). Enhances bio-ethanol production from cellulose materials by semi-simultaneous saccharification and fermentation using high temperature resistant *Saccharomyces cerevisiae* TJ14. *Bioscience and Bioengineering*,115:20–23.

Shahzadi, T., Anwar, Z., Iqbal, Z., Anjum, A., Aqil, T., Bakhtawar., Afzal, A., Kamran, M., Mehmod, S. and Irshad, M. (2014). Induced production of exoglucanase, and β-glucosidase from fungal co-culture of *T. viride* and *G. lucidum*. *Advances in Bioscience and Biotechnology* 5: 426-433.

Shajahan, S., Moorthy, I.G., Sivakumar, N. and Selvakumar, G. (2017). Statistical modeling and optimization of cellulase production by *Bacillus licheniformis* NCIM 5556 isolated from the hot spring, Maharashtra, India. *Journal of King Saud University-Science* 29: 302-310.

Sharma, S., Sharma, V. and Kuila, A. (2016). Cellulase production using natural medium and its application on enzymatic hydrolysis of thermochemically pretreated biomass. *3 Biotech* 6:139.

Shi, J., Chinn, M. S. and Sharma-Shivappa, R. R. (2008). Microbial pretreatment of cotton stalks by solid state cultivation of *Phanerochaete chrysosporium*. *Bioresource Technology*, 99: 6556-6564.

Shirkavand, E. Baroutian, S. Gapes, D.J. and Young, B.R. (2016). Combination of fungal and physicochemical processes for lignocellulosic biomass pretreatment – a review. *Renewable and Sustainable Energy Reviews*, 54: 217-234.

Shu, G., Yang, H., Chen, H. and Wang, S. (2013). Optimization of cellulase production by *Trichoderma reesei HY07* using response surface methodology. *Research Journall of Applied Science, Engineering and Technology* 5(23): 5438-5442.

Sindhu, R., Binod, P. and Pandey, A. (2016). Biological pretreatment of lignocellulosic biomass - An overview. *Bioresource Technology*, 199: 76-82.

Singh, A., Patel, A.K., Adsul, M., Mathur, A. and Singhania, R.R. (2017). Genetic modification:a tool or enhancing cellulose secretion. *Biofuel Research Journal,* 4: 600–610.

Singh, R., Kumar, M., Mittal, A. and Mehta, P.K. (2016). Microbial enzymes: industrial progress in 21st century. *3 Biotech* 6:174.

Singh, R., Shukla, A., Tiwari, S. and Srivastava, M. (2014). A review on delignification of lignocellulosic biomass for enhancement of ethanol production potential. *Renewable and Sustainable Energy Reviews*, 32: 713-728.

Singhania, R.R., Patel, A.K., Pandey, A. and Ganansounou, E. (2017). Genetic modification: atool for enhancing beta-glucosidase production for biofuel application. *Bioresource Technology*, 245: 1352–1361.

Singhania, R.R., Patel, A.K., Sukumaran, R.K., Larroche, C. and Pandey, A. (2013). Role and significance of beta-glucosidases in the hydrolysis of cellulose for bioethanol production. *Bioresource Technology*, 127:500-507.

Singhania, R.R., Sukumaran, R.K. and Pandey, A. (2007). Improved cellulase production by *Trichoderma reesei* RUT C30 under SSF through process optimization. *Applied Biochemistry and Biotechnology*, 142(1): 60-70.

Soccol, C.R., Ferreira da Costa, E.S., Letti, L.A.J., Karp, S.G., Woiciechowski, A.L. and Vandenberghe, L.P.S. (2017). Recent developments and innovations in solid state fermentation. *Biotechnology Research and Innovation*. http://dx.doi.org/10.1016/j.biori.2017.01.002.

Sohail, M., Ahmad, A. and Khan, S.A. (2016). Production of cellulase from *Aspergillus terreus* MS105 on crude and commercially purified substrates. *3 Biotech*. 6(1): 103.

Soltys, J., Mi, Y.Y., Hu, B.Y. (2014). The oil production of *Fusarium equiseti* UMN-1. http://conservancy.umn.edu/handle/11299/162359.

Sorek, N., Yeats, T.H., Szemenyei, H., Youngs, H. and Somerville, C.R. (2014). The implications of lignocellulosic biomass chemical composition for the production of advanced biofuels. *BioScience*, 64(3): 192-201.

Sorensen, A., Lübeck, M., Lübeck, P.S. and Ahring, B.K. (2013). Fungal beta-glucosidases: A bottleneck in industrial use of lignocellulosic materials. *Biomolecules*, 3: 612-631.

Srivastava, N., Srivastava, M., Mishra, P.K., Singh, P. and Ramteke, P.W. (2015). Application of cellulases in biofuels industries: an overview. *Journal of Biofuels and Bioenergy* 1(1): 55-63.

Sukumaran, R.K, Singhania, R.R. and Pandey, A. (2005). Microbial cellulases-production, application and challenges. *Journal of Scientific & Industrial Research* 64: 832-844.

Sukumaran, R.K., Singhania, R.R., Mathew, G.M. and Pandey, A. (2009). Cellulase production using biomass feedstock and its application in lignocellulose saccharification for bio-ethanol production. *Renewable Energy* 34: 421-424.

Suwannarangsee, S., Arnthong, J., Eurwilaichitr, L. and Champreda, V. (2014). Production and characterization of multi-polysaccharide degrading enzymes from *Aspergillus aculeatus* BCC199 for saccharification of agricultural residues. *Journal of Microbiology and Biotechnology*, 24(10): 1427-1437.

Sweeney, M.D. and Xu, F. (2012). Biomass converting enzymes as industrial biocatalysts for fuels and chemicals: recent developments. *Catalysts* 2012(2): 244-263.

TAPPI (Technical Association of paper and pulp industry). (1992). *Technical Association of Pulp and Paper Industry*, Atlanta, Georgia, USA.

Taha, M., Foda, M., Shahsavari, E., Aburto-Medina, A., Adetutu, E. and Ball, A. (2016). Commercial feasibility of lignocellulose biodegradation: possibilities and challenges. *Current Opinion in Biotechnology* 38: 190-197.

Taherzadeh, M.J. and Karimi, K. (2008). Pretreatment of lignocellulosic wastes to improve ethanol and biogas production: a review. *International Journal of Molecular Sciences,* 9: 1621-1651.

Teugjas, H. and Väljamäe, P. (2013). Selecting β-glucosidases to support cellulases in cellulose saccharification. *Biotechnology for Biofuels* 6:105.

Thongekkaew, J. and Konsanthia, J. (2016). Screening and identification of cellulase producing yeast from Rongkho Forest, Ubon Ratchathani University. *Bioengineering and Bioscience* 4(3): 29-33.

Thongekkaew, J., Khumsap, A. and Chatsa-nga, P. (2012). Yeasts in mixed deciduous forest areas of Phujong Nayoy National Park and their ability to produce xylanase and carboxymethyl cellulase. *Songklanakarin Journal of Science and Technology* 34(2): 157-163.

Tirado-Gonzalez, D.N., Juaregui-Rincon, J., Tirado-Estrada, G.G., Martinez-Hernandez, P.A., Guevara-Lara, F. and Miranda-Romero, L.A. (2016). Production of cellulases and xylanases by white-rot fungi cultured in corn stover media for ruminant feed applications. *Animal Feed Science and Technology* 221(2016): 147-156.

Tiwari, P., Misra, B.N. and Sangwan, N.S. (2013). β-glucosidases from the fungus *Trichoderma*: an efficient cellulase machinery in biotechnological applications. *BioMed Reseacrh International* 2013:1-10.

Treebupachatsakul, T., Shioya, K., Nakazawa, H., Kawaguchi, T., Morikawa, Y. and Shida, Y. (2015). Utilization of recombinant *Trichoderma reesei* expressing *Aspergillus aculeatus* β-glucosidase I (JN11) for a more economical production of ethanol from lignocellulosic biomass. *Journal of Bioscience and Bioengineering,* 120: 657–665.

Trivedi, N., Reddy, C.R.K., Radulovich, R. and Jha, B. (2015). Solid state fermentation (SSF)-derived cellulase for saccharification of the green seaweed *Ulva* for bioethanol production. *Algal Research* 9(2015): 48-54.

Vaidya, B.K., Mutalik, S.R., Joshi, R.M., Nene, S.N., Kulkarni, B.D., 2009. Enhanced production of amidase from *Rhodococcus erythropolis* MTCC 1526 by medium optimisation using a statistical experimental design. *Journal of Industrial Microbiology & Biotechnology*, 36: 671–678.

Van Acker, R., Leple, J.C., Aerts, D., Storme, V., Goeminne, G., Ivens, B., Legee, F., Lapierre, C., Piens, K., Van Montagu, M.C.E., Santoro, N., Foster, C.E., Ralph, J., Soetaert, W., Pilate, G., Boerjan, W. (2014). Improved saccharification and ethanol yield from field-grown transgenic poplar deficient in cinnamoyl-CoA reductas. *Proceeding of the National Academy of Sciences of USA* 111(2): 845-850.

Vanessa de Cássia Teixeira da Silva, Souza Coto, A.L., Carvalho Souza, R., Neves, M.B.S., Gomes, E. and Bonillo-Rodriguez, G.O (2016). Effect of pH, temperature, and chemicals on the endoglucanases and β-

Glucosidases from the thermophilic fungus *Myceliophthora heterothallica* F.2.1.4. obtained by solid-state and submerged cultivation. *Biochemistry Research International*, 2016: 9.

Varnai, A., Viikari, L., Marjamaa, K. and Siika-ho, M. (2011). Adsorption of monocomponent enzymes in enzyme mixture analyzed quantitatively during hydrolysis of lignocellulose substrate. *Bioresource Technology*, 102(2011): 1220-1227.

Vastrad, B.B. and Neelagund, S.E. (2014). Optimization of medium composition for the production of neomycin by *Streptomyces fradiae* NCIM 2418 in solid state fermentation. *Biotechnology Research International* 2014:1-11

Viji, J. and Neelanarayanan, P. (2015). Efficacy of lignocellulolytic fungi on the biodegradation of paddy straw. *International Journal of Environmental Research* 9(1): 225-232.

Vyas, S. and Chabra, M. (2017). Isolation, identification and characterization of *Cystobasidium oligophagum* JRC1: a cellulase and lipase producing oleaginous yeast. *Bioresources Technology* 223(2017): 250-258.

Walker, G.M. (2010). *Bioethanol: Science and technology of fuel alcohol*. Graeme M. Walker & Ventus Publishing.

Wang, M, and Lu, X. (2016). Exploring the synergy between cellobiose dehydrogenase from *Phanerochaete chrysosporium* and cellulase from *Trichoderma reesei*. *Frontiers in Microbiology*, 7(620).

Yoon, L.W., Ngoh, G.C. and Chua, A.S.M. (2013). Simultaneous production of cellulase and reducing sugar through modification of compositional and structural characteristics of sugarcane bagasse. *Enzyme and Microbial Technology*, 53: 250-256.

Yoon, L.W., Ang, T.N.A., Ngoh, G.C. and Chua, A.S.M. (2014). Fungal solid-state fermentation and various methods of enhancement in cellulase production. *Biomass & Bioenergy* 67: 319-338.

Zadrazil, F. and Puniya, A.K. (1995). Studies on the effect of particle size on solid-state fermentation of sugarcane bagasse into animal feed using white-rot fungi. Short communication. *Bioresources Technology,* 54: 85-87.

Zaldivar, M. (2001). *Trichoderma aureoviride* 7-121, a mutant with enhanced production of lytic enzymes: its potential use in waste cellulose degradation and/or biocontrol. *Electronic Journal of Biotechnology,* 4(3).

Zhang, Q. and Bao, J. (2017). Industrial cellulase performance in the simultaneous saccharification and co-fermentation (SSCF) of corn stover for high-titer ethanol production. *Bioresources and Bioprocessing* 4:17.

Zhang, X.Z. and Zhang, Y.H.P. (2013). Cellulase: characteristics, sources, production, and applications. In Shang-Tian Yang, Hesham A. El-Enshasy and Nuttha Thongcul (Ed.), *Bioprocessing Technologies in Biorefinery for Sustainable Production of fuels, Chemicals, and Polymers* (pp. 131-146). John Wiley & Sons, Inc. Publisher.

Zhang, Y.H.P., Himmel, M.E. and Mielenz, J.R. (2006). Outlook for cellulase improvement: screening and selection strategies. *Biotechnology Advances* 24: 452-481.

Zheng, Y., Zhao, J., Xu, F. and Li, Y. (2014). Pretreatment of lignocellulosic biomass for enhanced biogass production. *Process in Energy and Combustion Sciences*, 42: 35-53.

Zhou, S., Raouche, S., Grisel, S., Navarro, D., Sigoilot, J.C. and Herpoel-Gimbert, I. (2015). Solid-state fermentation in multi-well plates to assess pretreatment efficiency of rot fungi on lignocellulose biomass. *Microbial Biotechnology* 8(6): 940-949.