UNIVERSITI PUTRA MALAYSIA

BIOLOGICAL PRE-TREATMENT OF BANANA PSEUDO STEM WITH WHITE ROT FUNGI AND ITS EFFECTS ON PULP AND PAPER PROPERTIES

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By

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Chairman : Assoc Prof. Rasmina Halis, PhD
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Wood fibre is known to be a major raw material for most paper industries all over the world. However, a great concern in forest resources conservation calls for an overall plan for utilization of non-woody plants. This study was carried out using banana pseudo stem (*Musa acuminata var. truncata*) as potential raw material for pulp and paper. In paper production, chemicals disposal process requires high cost and causes negative effects to the environment. Biopulping has showed potential in providing environmentally-friendly technology for pulp and paper production. This research was aimed at investigating the effect of fungi pre-treatment in lignin removal prior to the pulping process and their effect to the pulp and paper properties. Research studies have been geared toward properties of banana pseudo stem, fungi pre-treatment on banana pseudo stem, optimisation of soda pulping process and biosoda pulping process.

Properties of banana pseudo stem include botanical aspects, anatomical structures, fibre morphology and chemical compositions. From the anatomical observation, it showed that banana pseudo stem consists of fibre bundle, vascular bundle and lots of parenchymatous cells. Banana pseudo stem fibres were discovered to have long fibre which range from 3.34 mm to 4.19 mm and had lower runkel ratio, high coefficient of suppleness and higher felting power. Chemical composition of banana pseudo stem consisted of more holocellulose (71.68%), alpha-cellulose (68.30%) and remarkable lower lignin content (14.34%).

Fungal pre-treatment study was carried out to determine the best fungus species and a suitable pre-treatment period to be used in biosoda pulping. The pre-treatment was done using banana chips that were inoculated with *Pycnoporus sanguineus* and *Oxyporus latemarginatus* in 5, 10 and 15 days incubations. *P. sanguineus* appeared to grow much faster compared to *O. latemarginatus* on banana chips and gave the highest weight loss (29.36%). *P. sanguineus* secreted sole ligninolytic enzyme Laccase with the highest level of activity which was 6.07 U/ml in 15 days and showed preference to degrade

mainly on lignin (24.85% reduction) with minimal loss of holocellulose and alpha-cellulose. *O. latemarginatus* was found to secrete lignin peroxidase and manganese peroxidase and appeared to degrade more on lignin (18.92%) and cellulose (45.93%).

Soda pulping process was carried out at different cooking time (30 and 60 mins) and different alkali percentage (10, 12, 14 and 16%). It was found that a combination of 30 mins cooking time and 14% alkali produced higher pulp yield (40.91%) and also gave better result in pulp and paper properties.

Biosoda pulping was carried out using. *P. sanguineus* with the incubation period of 15 days. Pulp and paper properties of soda pulping and biosoda pulping were compared. Biosoda pulping appeared to give the highest pulp yield with 47.57% and also better in tensile index, burst index, and tear index and also brightness. Scanning Electron Microscope (SEM) observation of treated handsheets indicated that there were less voids between fibres, and the fibres collapsed onto each other which contributed to good bonding. From the research, the fungal pre-treatment prior to pulping process helped to improve pulp and paper properties.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan Ijazah Doktor Falsafah

PRA-RAWATAN BIOLOGI KE ATAS BATANG PISANG DENGAN MENGGUNAKAN KULAT PUTIH DAN PENGARUHNYA TERHADAP SIFAT PULPA DAN KERTAS

Oleh

NORHASLIDA BINTI RAZALI

November 2015

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Gentian kayu merupakan bahan utama dalam industri kertas di dunia ini. Walaubagaimanapun, kesedaran yang timbul terhadap pemuliharaan sumber hutan telah memperkenalkan penggunaan tumbuhan bukan kayu. Kajian ini dijalankan dengan menggunakan batang pisang (pisang hutan) sebagai bahan mentah yang dilihat berpotensi untuk industri pulpa dan kertas. Dalam penghasilan kertas, proses pelupusan bahan kimia ini memerlukan kos yang tinggi dan mendatangkan kesan buruk terhadap alam sekitar. Bio pemulpaan dilihat berpotensi dalam menghasilkan teknologi pembuatan kertas yang mesra alam. Kajian ini adalah bertujuan untuk mengenal pasti kesan pra-rawatan kulat sebelum proses pemulpaan dalam menceraikan lignin dan kesannya terhadap sifat pulpa dan kertas yang dihasilkan. Kajian ini meliputi pencirian terhadap sifat-sifat batang pisang, pra-rawatan kulat ke atas batang pisang, serta penghasilan mempulpa soda dan biosoda yang optimum.

Sifat-sifat batang pisang meliputi aspek botani, anatomi, morfologi gentian dan kandungan kimianya. Struktur anatomi menunjukkan batang pisang terdiri daripada kelompok-kelompok gentian, kelompok-kelompok vaskular dan taburan tisu parenkima yg banyak. Batang pisang didapati mempunyai gentian yang panjang dengan purata gentian sepanjang 3.34mm hingga 4.19mm dan mempunyai nisbah runkel yang lebih rendah dan tinggi pekali kelembutan dan kuasa lipatan. Gentian mempunyai kandungan kimia holoselulosa (71.68%), alfa-selulosa (68.30%) dan lignin (14.34%).

Kajian pra-rawatan kulat dijalankan untuk menentukan spesies kulat terbaik dan tempoh masa pengeraman yang sesuai. Cip batang pisang dirawat dengan mengunakan *Pycnoporus sanguineus* dan *Oxyporus latemarginatus* selama 5, 10 dan 15 hari. *P. sanguineus* dilihat membiak dengan cepat berbanding *O. latemarginatus* dan memberikan pengurangan berat yang paling tinggi (29.36%) ke atas cip pisang. *P. sanguineus* hanya merembeskan enzim laccase dengan kadar tertinggi sebanyak 6.07 U/ml yang dilihat pada hari ke-15 dan menunjukkan keutamaan mengdegradasi lignin (24.85% pengurangan)

berbanding holoselulosa dan alfa selulosa. *O. latemarginatus* merembeskan enzim Lignin peroxidase dan manganese peroxidase dan mengdegradasi lebih kepada lignin (18.92%) dan selulosa (45.93%).

Mempulpa secara soda dijalankan dengan masa masakan yang berbeza (30 dan 60 minit) dengan kepekatan alkali yang berbeza (10, 12, 14 dan 16%). Mempulpa secara soda ke atas cip pisang yang dimasak pada pembolehubah yang berbeza menunjukkan kombinasi 30 minit masa masakan dan 14% kepekatan alkali menghasilkan pulpa yang banyak (40.91%) dan memberi sifat kertas yang paling baik.

Pemulpaan biosoda telah dijalankan menggunakan *P. sanguineus* dengan pengeraman selama 15 hari. Sifat pulpa dan kertas daripada pemulpaan soda dan biosoda dibandingkan. Keputusan menunjukkan bahawa mempulpa secara biosoda menghasilkan pulpa sebanyak 47.57% dengan indeks regangan, indeks pecahan, indeks koyakan dan kecerahan yang lebih baik. Pemerhatian daripada SEM menunjukkan kertas terawat kurang lompang antara gentian dan gentian jatuh di antara satu sama lain menghasilkan prekatan yang baik. Daripada kajian ini, didapati pra-rawatan kulat sebelum proses mempulpa membantu meningkatkan sifat-sifat pulpa dan kertas.

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I certify that a Thesis Examination Committee has met on 26 November 2015 to conduct the final examination of Norhaslida binti Razali on her thesis entitled "Biological Pre-treatment of Banana Pseudo Stem with White Rot Fungi and its Effects on Pulp and Paper Properties" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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

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LIST OF ABBREVIATIONS

AA	Alcohol acetone
AD	Air dried
AC	Alpha cellulose
ANOVA	Analysis of variance
APMP	Alkaline Peroxide Mechanical pulping
CED	cupriethylenediamine
CO_2	Carbon dioxide
COD	Chemical oxygen demand
$C_2H_4O_2$	Glacial acetic acid
CSF	Canadian standard of freeness
CSL	Corn steep liquor
C. versicolor	*Coriolus versicolor*
CW	Cold water
DP	Degree of polymerization
ECF	Elemental chlorine free
FRIM	Forest Research Institute Malaysia
HW	Hot water
HC	Holocellulose
$KMnO_4$	Kalium permanganate
Lac	Laccase
LiP	Lignin peroxidase
MC	Moisture content
MnP	Manganese peroxidase
Mt	Million tonne

$NaClO_2$	Sodium Chlorite
NaOH	Sodium hydroxide
OD	Oven dried
O. latemarginatus	*Oxyporous latemarginatus*
P. chrysosporium	*Phanerochatae chrysosporium*
P. sanguineus	*Pycnoporus sanguineus*
PDA	Potato dextrose agar
PEG	Polyethylene glycol
RMP	Refiner mechanical pulp
SEM	Scanning Electron Microscope
SSF	Solid state fermentation
TAPPI	Technical Association of the Pulp and Paper Industry
TCF	Totally chlorine free
TEM	Transmission Electron Microscope
TMP	Thermomechanical pulp

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background move

The pulp and paper industry is one of the largest industrial sector in the world, and an important source of employment in many countries. A sustainably managed pulp and paper industry can bring many benefits to the local economy and people, particularly in rural areas. The demand for paper and the unacceptable large ecological footprint of current paper production requires the need for alternatives in terms of new raw materials and improved processing methods for paper production. Roughly, more than 1 Mt of paper are used every day (Anon, 2013).

In many parts of the world, local supplies of wood cannot support the demand for pulp. As a result, the search for non-wood raw materials in paper making industry has been given more attention due to the rising consumption of wood resources for the paper production. From 1970s to present time, the non-wood plant fibre pulping capacity has increased on a global basis two to three times as fast as the wood pulping capacity. It was also forecasted that during the next decade, the non-wood pulp production will annually grow at an average of 6%, which is three times as fast as the production of pulp on wood basis. Initially, non-wood fibre pulping occurred in regions where wood supply had been reduced to levels insufficient to sustain paper making, and an alternative source of fibre feedstock was mandatory (Laftah and Abdul Rahaman, 2015). Non-wood lignocellulosic fibre resources have the potential to complement conventional wood supplies because it does not compete with agricultural crops for fertile land, relies on larger biomass yields, have short cycles and rapid regeneration, and are of comparatively low price (Cherubini, 2010).

Banana pseudo stem is one example of non-wood fibres, which can be described as lignocellulosic that comprises primarily of cellulose, hemicellulose and lignin (Khalil *et al*., 2006; Norhaslida *et al*., 2014; Low *et al*., 2015). In Malaysia, as the second most widely cultivated fruit crop, banana cultivation covers almost 10% or 33,584 ha of the total fruit area (297,860 ha), with a total production of 535,000 tonnes (Mohamad Roff *et al*., 2012; Low *et al*., 2015). Banana pseudo stem produces a large amount of biomass residues (approximately 88% of the banana plant), and in Malaysia it is usually discarded as an agricultural waste from banana plantation (Low *et al*., 2015). Banana stem has long been known as one of the potential cellulose sources and recommended as a suitable source of fibre for pulp and paper industry (Faria *et al*., 2006). Cellulose is a linear and high molecular weight polymer of natural and biodegradable material that can be found in the banana pseudo stem.

The pulp and paper industry is traditionally known to be the large contributor to environmental world pollution due to its large consumption of energy and

chemicals. Biotechnological methods offer potential opportunities for changing the pulp and paper industry towards more environmentally friendly and efficient operations compared to the conventional method (Ferraz *et al*., 2008). Biotechnology in pulp and paper industry has found its way in the commercialized applications in using pre-treatment with microorganisms (bacteria, fungi, enzymes etc.) in biopulping, biobleaching, biodeinking, pulp and paper mill effluents (Bajpai, 2006; Fatriasari *et al*., 2010; Fillat *et al*., 2012; Singh *et al*., 2013; Sharma *et al*., 2015;).

Biopulping is the fungal pre-treatment with wood decay fungi to biodegrade wood chips and other lignocellulosic materials prior to mechanical or chemical pulping. This pre-treatment intensively alters and removes lignin and other chemical compound in the substrate (wood chips) especially extractives, hemicellulose and ash content. Biopulping provides several benefits where the pre-treatment process helps to soften and loose the fibres, improves chemical penetration and reduces electrical energy during chemical and mechanical pulping (Van beek *et al*., 2007; Islam *et al*., 2008; Rosli *et al*., 2008). In some cases, it helps to increase pulp yield, improves fibre properties and enhances paper quality. One of the promising microorganisms for biological pre-treatment is white rot fungi that belong to class basidiomycete.

White rot fungi have a remarkable ability to produce hydrolytic and oxidative extracellular enzymes i.e. laccase (Lac), manganese peroxidase (MnP), lignin peroxidase (LiP) and cellulase that simultaneously degrade biomass especially lignin and carbohydrate (Dhouib *et al*., 2005; Dashtban *et al*., 2009; Ashger *et al*., 2012; Rozi *et al*., 2013). Based on the study by Halis *et al*. (2012), *Pycnoporous sanguineus* was found to secrete only Lac and the activity of enzyme can be detected since week 1. While the other fungi, *Oxyporus latemarginatus* showed to produce high rate of MnP and trace of LiP. Rozi *et al*. (2013) who studied on the enzyme activity of four white rot fungi (*O. latemarginatus, Rigidoporus vinctus, Phanerochaete chrysosporium* and *Coriolus versicolor*) found that all fungi produced all the three ligninolytic enzymes (Lac, LiP and MnP). *O. latemarginatus* secreted highest level of LiP that plays a major role in lignin degradation. For cellulase activity, all four species were found to produce endoglucanase, exoglucanase and β-glucosidase where *O. latemarginatus* showed the highest activity for all the three enzymes. So, *P. sanguineus* and *O.latemarginatus* were found to have the potential to be applied in pre-treatment of banana pseudo stem in this study.

1.2 Problem statement

Forests cover a total of 4 billion hectares worldwide, equivalent to 31% of the total land area (FOA, 2010). Although this figure may seem high, the world's forests are disappearing. Between 1990 and 2000 there was a net loss of 8.3 million hectares per year, and the following decade, up to 2010, there was a net loss of 6.2 million hectares per year (FOA, 2010). Aside from the devastating effects of tropical forest loss has on biodiversity and forest-dependent communities, a major consequence of deforestation and forest degradation is the release of heat-trapping carbon dioxide (CO_2) into the

atmosphere. Forests provide vast carbon sinks that when destroyed emit CO_2 into the atmosphere, either by burning or degradation of organic matter (Moutinho and Schwartzman, 2005). The pulp and paper sector was estimated to generate more than 600 mt of CO_2 emissions per year.

Non-wood plant fibres are another alternative sources of material for the pulp and paper productions and it is also to reduce the forest exploitation and a way of promoting sustainable paper production especially in areas of lacking forest and abundance of annual fibre resources (Ogunsile *et al*., 2006). Banana pseudo stem is one of the plant fibres that usually discarded as an agricultural waste. This residue can generate great environmental problems when left on the plantation floor. Indirectly, it also can create problems in replanting operations. This residue can turn out to be a source for other value-added products such as pulp and paper. Therefore, exploitation of the banana pseudo stem will be significantly beneficial to the environment and brings additional profits to farmers (Li *et al*., 2010). In particular previous studies on banana pseudo-stem, it has proven that banana pseudo-stem has approximately higher content of cellulose (64-65%) and has lower content of lignin (11%). It is also has a long and high fibre strength which is suitable for pulp and paper making (Rasmina *et al*., 2011; Norhaslida *et al*., 2014).

The pulp and paper industry is looking towards technological improvement in the conventional pulping methods. However, it probably will eventually be necessary to shift to even newer technologies to meet industrial and consumer needs, as well as the environmental requirements. The chemical pulping process is aimed to selectively extract lignin from lignocellulosic material. High cost and energy are needed in order to dispose chemicals in pulp and paper processing. This will cause negative effects to the environment, such as chlorine-based organic compound. Therefore, alternative pulping process such as biopulping is needed in order to reduce environmental pollution and at the same time improve the reduction of pulping time, and improve the properties of pulp (Wolfaardt *et al*., 2004). Biopulping can be used as a potential solution or eliminating some of the ordinary pulping problems (Rasmina *et al*., 2010; Singh *et al*., 2013).

However, not all the fungi are suitable for biopulping. *P. sanguineus* and *O. latemarginatus* were selected in this study based on the previous findings (Rasmina 2010; Tan, 2012; Rozi *et al*., 2013) which are selective lignin degraders. The enzymatic activity by *P. sanguineus* (Lac, 0.006 U/mL) and *O. latemarginatus* (MnP, 0.0035 U/mL and LiP, 0.0006 U/mL) were the highest detected during fungal pre-treatment (Halis *et al*., 2012). Apart from that, comprehensive study on biosoda pulping of banana has not yet been established. In order to understand the mechanism of biosoda pulping, several parameters have to be examined and optimized especially on pre-treatment conditions (fungi species, inoculum sizes, chip pre-treatment, incubation time) and right cooking conditions for soda and biosoda pulping (cooking time, active alkali, wood to liquor ratio and cooking temperature).

1.3 Objectives

The general objective was to investigate the effect of fungal pre-treatment in biopulping process on pulp and paper properties of banana pseudo stem.
The specific objectives of the study are:

1) To analyze the anatomical structure, fibre morphology and chemical constituents of banana pseudo stem.
2) To characterize the fungi morphology and optimize the fungi pre-treatment conditions.
3) To determine the best cooking time on soda pulping for banana pseudo stem.
4) To evaluate the pulp and paper properties of biosoda pulping.

REFERENCES

Abd Rahman, N.S. and Azahari, B. 2012. Effect of calciul hydroxide filler loading on the properties of banana stem handsheets. *BioResources* 7(3): 4321-4340.

Agarwal, N.K., Khanna, N.K., Chechi, S.K., Patel K.I., Pawar, S.L. and Patil, R.G. 2011. Evaluation of banana pseudostem based fibre as pulp and paper making raw material. *IPPTA Journal* 24(3): 119-124.

Akhtar, M., Attridge, M.C., Myers, G.C. and Blanchette, R.A. 1993. Biomechanical pulping of loblolly pine chips with selected white rot fungi. *Holzforschung* 47: 36-40.

Akhtar, M. 1998. *Method of Enhancing Biopulping Efficiency.* United States patent document: 5620564.

Ali, M. and SreeKrishnan, T.R. 2007. Anaerobic treatment of agricultural residue based pulp and paper mill effluents for AOX and COD reduction. *Process Biochemical* 36(1-2): 25-29.

Alina, I., Raluca, N., Florin, C. and Elena, B. 2010. Influence of recovered paper quality on recycled pulp properties. *Cellulose Chemistry and Technology* 44(10): 513-19.

Ana, M.M. Concepción, M., Elena, C. and Angeles, B. 2010. Morphological characterization of pulps to control paper properties. *Cellulose Chemisrty and Technology* 44(10): 473-80.

Anonymous. 1955. The relationship between the morphological characteristic of the fibres from tropical woods and the quality of the pulp and paper obtained from them. Pulp and paper prospects in Latin America. Regie Industrielle de la Cellulose Coloniale.FAO. Rome. Pp 378-380.

Anonymous, 2013. Forestindustries- Forerunner in the bioeconomy. Retrieved 30 September 2014 from http://www.forestindustries.fi/industry/paper_cardboard_converted/paper_pulp/Global-paper-consumption-is-growing-1287.html

Anonymous. 2013. Pulp and paper industry in New Zealand. Retrieved June 2013 from http://nzic.org.nz/ChemProcesses/forestry/4C.pdf.

Antunes, A., Amaral, E. and Belgacem, M.N., 2000. *Cynara cardunculus L*.: chemical composition and soda-anthraquinone cooking. *Industrial Crops Products* 12: 85–91.

Arai, T., Harino, H., Ohji, M., and Langston, W. (Eds) (2009); Ecotoxilogy of antifouling biocide. Springer, XV11, 437 p.

Arora, D.S. and Gill, P.K. 2001. Comparison of two assay procedures for lignin peroxidase. *Enzyme and Microbial Technology* 28(7): 602-605.

Arora, D.S., Chander, M. and Gill, P.K. 2002. Involvement of lignin peroxidase, manganese peroxidase and laccase in degradation and selective ligninolysis of wheat straw. *International Biodeterioration and Biodegradation* 50: 115-120.

Arsene, M.A., Savastano, H.J., Allameh, S.M. Ghavami, K. and Soboyejo, W.O. 2001. Cementitious composites reinforced with vegetable fibres. Guadeloupe (FWI): Laboratoire COVACHIMM.

Ashger, M., Iqbal, H.M.N. and Asad, M.J. 2012. Kinetic characterization of purified laccase produced from *Trametes versicolor* IBL-04 in solid state bio processing of corn cobs. *BioResources* 7 (1): 1171-1188.

Ashger, M., Iqbal, H.M.N. and Irshad, M. 2012. Characterization of purified and xerogel immobilized novel lignin peroxidase produced from *Trametes versicolor* IBL-04 using solid state medium of corncobs. *Biomedical Central Biotechnology* 12(1): 46.

Atchison, J.E. and McGovern, J.N. 1983. History of paper and the importance of non-wood plants fibres. In *Pulp and Paper Manufacturer,* ed. M.J. Kocurek and F. Stevens, pp. 1-3. Atlanta GA: TAPPI Press.

Atchison, J.E. 1993. Data on non-wood plant fibers. In *Pulp and Paper Manufacture*, ed. F.L. Hamilton, pp. 157–163. Atlanta: TAPPI Press.

Ates, S., Ni, Y., Akgul, M. and Tozluoglu, A. 2008. Characterization and evaluation of *Paulownia elongota* as a raw material for paper production. *African Journal of Biotechnology* 7(22): 4153-4158.

Babu, P.R., Pinnamaneni, R. and Koona, S. 2012. Occurrences, Physical and Biochemical Properties of Laccase. *Universal Journal of Environmental Research and Technology* 2(1): 1-13.

Bajpai, P. 1999. Application of enzymes in pulp and paper industry. *Biotechnology programme* 15(2): 147-157.

Bajpai, P. 2006. *Biotechnology for pulp and paper processing.* Springer New York Dordrecht Heidelberg London.

Bajpai, P. 2006. Potential of biotechnology for energy conservation in pulp and paper; energy management for pulp and papermakers, Budapest, Hungary, 16-18 Oct. 2006. Paper 11, pp. 29.

Bajpai, P. 2009. Xylanases. In *Encyclopedia of Microbilogy,* ed. M. Schaechter and J. Lederberg, pp. 600-612. San Diego: Academic.

Bajpai, P. 2012. *Biotechnology for Pulp and Paper Processing.* New York, Dordrecht Heidelberg: Springer.

Bajpai, P. 2014. *Recycling and Deinking of Recovered Paper*. Elsevier.

Belgacem, M.N., Zid, M., Nicolski, S.N., Obolenskaya, A.V., 1986. Study of the chem-ical composition of alpha from Tunisia. Chim. Technol. Drev. Mej. Sbor. Trud. 8(1): 111–114.

Bicho, P., Gee, W., Yuen, B., Mahajan, S., McRae, M., and Watson, P. 1988. In *Characterization of Canadian agricultural residues and their pulps*. Proceedings of the TAPPI Pulping Conference, Oct. 31–Nov. 4, 1999. Orlando, F.L. (Ed.); TAPPI Press: Atlanta, GA, 2: 829–837.

Blackwell M. 2011. The fungi: 1, 2, 3 …5.1 million species. *American Journal of Botany* 98(3): 426–38.

Blanchette, R.A., 2003. Deterioration in historic and archaeological woods from terrestrial sites. In *Art, Biology and Conservation: Biodeterioration of Works of Art*, ed. R.J. Koestler, V.R. Koestler, A.E. Charola, F.E. Nieto Fernandez, pp. 328-347. New York: Metropolitan Museum of Art.

Breen, A. and Singleton, F.L. 1999. Fungi in lignocellulose breakdown and biopulping. *Journal of Current Opinion in Biotechnology* 10(7): 252-257.

Buswell, J.A., Cai, Y. and Chang, S.T. 1995. Effect of nutrient and manganese on manganese peroxidase and laccase production by *Lentinula* (Lentinus) *edodes*. *FEMS Microbiology Letter* 128: 81-88.

Cai, W.X. and Tao, J.H. 2007. Pulping properties of massion pine and small diameter bamboos. *China Pulp and Paper Industry* 28(1): 16-17.

Camarero, S., Sarkar, S., Ruiz-Dueñas, F.J., Martinez, M.J. and Martinez, A.T. Description of a versatile peroxidase involved in the natural degradation of lignin that has both manganese peroxidase and lignin peroxidase substrate interaction sites. *Journal of Biological Chemistry* 274(15): 10324-30.

Carter, J. S. 2011. Properties of cellulose. *Cellulose and paper* 37-40.
Casey, J.P. *Pulp and paper: Chemistry and Chemical Technology*; 3rd Ed.; Wiley & Sons: New York. 1980.

Cheirsilpa, 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.

Cheng, Z. and Paulapuro, H. 1996a. In *Influence of Fines on Free Drainage of Wheat Straw Pulp*. Proceedings of the 3rd International Non-wood Fiber Pulping and Papermaking Conference, Beijing, China, Oct. 15-18, 1996. International Academic Publishers: Beijing, 2: 431–440.

Cheng, Z. and Paulapuro, H. 1996b. In *Vacuum Dewatering of Wheat Straw Pulp*. Proceedings of the 3rd International Nonwood Fiber Pulping and Papermaking Conference, Beijing, China, Oct. 1518, 1996. International Academic Publishers: Beijing, 2: 514-523.

Cheng, X., Jia, R., Li, P., Tu, S., Zhu, Q., Tang, W. and Li, X. 2007. Purification of a new manganese peroxidase of the white-rot fungus *Schizophyllum sp.* F17, and decolorization of azo dyes by the enzyme *Schizophyllum sp.* F17, and decolorization of azo dyes by the enzyme. *Enzyme and Microbial Technology* 41(3): 258-64.

Cherubini, F. 2010. The biorefinery concept: using biomass instead of oil for producing energy and chemicals. *Energy Conversion Manage* 51: 1412-1421.

Clark, T.F., Cunningham, R.L. and Wolf, I.A. 1971. A search for new fibre crops. Part XIV. Bond paper containing continuously pulped kenaf. *Tappi Journal* 54(11): 63-65.

Clark, L.G. 1985. *Pulp technology and treatment for paper*. 2nd ed.; Miller Freeman Publicatios: San Francisco.

Cordeiro, N., Belgacem, M.N., Torres, I.C and Moura, J.V.C.P. 2004 Chemical composition and pulping of banana pseudo-stems. Industrial Crops and Products. 19(2): 147–154.

Cordeiro, N., Belgacem, M.N., Torres, I.C. and Moura, J.C.V.P. 2005. Pulp and paper from *Dwarf Cavendish* pseudostem. *Cellulose Chemistry Technology* 39: 517-529.

Cordeiro, N., Oliveira, L., Faria, H., Belgacem, M.N. and Moura, J.C.V.P. 2006. *Contact Angle, Wettability and Adhesion* 4: 387-405.

Couto, S.R. and Sanromán, M.A. 2006. Application of solid-state fermentation to food industry-a review. *Journal of Food Engineering* 76(3): 291–302.

Dadswell, H.E., Watson, A.J. and Nicholls, J.W.P. 1959. What are the wood properties required by the paper industry in the trees of future? *Tappi* 42(7): 521-526.

Dadswell, H.E. and Watson, A.J. 1962. Influence of the morphology of wood pulp fibres and paper properties. Technical Section of the British Paper and Bookmakers' Association Inc. London. pp. 537-572.

Danladi, A. and Shu'aib, J. 2014. Fabrication and properties of pineapple fibre / high density polyethylene composites. *American Journal of Materials Science* 4(3): 139-143.

Dashtban, M., Schraft, H., and Qin, W. 2009. Review: Fungal bioconversion of lignocellulosic residues; opportunities & perspectives. *International Journal of Biological Sciences* 5(6): 578-595.

Dashtban, M., Buchkowski, R. and Qin, W. 2011. Effect of different carbon sources of cellulase production by *Hypocrea jecorina* (*Trichodherma reesei*) straints. *International Journal Biochemistry and Biomolecular Biology* 2(3): 274–286.

Dashtban, M., Gilbert, A. and Fatehi, P. 2012. Production of furfural: overview and challenges. *Journal of Science & Technology for Forest Products and Processes* 2(4): 44-53.

De Loecker, R., Penninck, F. and Keremans, R. 1993. Osmotic effects of dilution on erythrocytes after freezing and thawing in glycerol-containing buffer. *Cryobiology* 30(3): 279-85.

Deniz, I., Kirci, H., and Ates, S. 2004. Optimization of wheat straw *Triticum drum* Kraft pulping. *Industrial Crops and Products* 19(3): 237-243.

Dhake, J.D. and Sapkal R.S. 1983. Utilization of banana (*Musa cavendishit*) stems and leaves in paper and board making. *India pulp and paper* 37(4): 5-8.

Dharani, G. and Kumaran N.S. 2012. Amylase production from solid state fermentation and submerged liquid fermentation by *Aspergillus niger*. *Bangladesh Journal of Scientific and Industrial Research* 47(1): 99–104.

Dhouib, A., Ellouz, M., Aloui, F. and Sayadi, S. 2005. Effect of bioaugmentation of activated sludge with white–rot fungi on olive mill wastewater detoxification. *Letters in Applied Microbiology* 42(4): 405-11.

Dhouib, A., Hamza, M., Zouari, H., Mechichi, T., H'midi, R., Labat, M., Martinez, M.J. and Sayadi, S. 2005. Autochthonous fungal strains with high ligninolytic activities from Tunisian biotepes. *African Journal of Biotechnology* 4(5): 431-436.

Dwivedi, U., Singh, P., Pandey, V. and Kumar, A. 2011. Laccases from new fungal sources and its promising application. *Journal of Molecular Catalysis B: Enzymatic* 68: 117-128.

Elwood, E.L., Hitchings, R.G. and Barefoot, A.C. 1965. Wood characteristics and kraft paper properties of four selected loblolly pines. ii. Wood chemical constituents and their relationship for fibre morphology. *Forest Products Journal* 15(8): 313-320.

Emerton, H.W. 1957. *Fundamentals of the beatings process*. London: Marshall Press. pp. 137.

Eom, T.J. and Ow, S.S.K. 1990. Process for removing printing ink from wastepaper. German patent GB 3, 934, 772

Eugenio, M.E., Carbajo, J.M., Martin, J.A., Gonzalez, A.E. and Villar, J.C. 2009. Laccase production by Pycnoporus sanguineus under different culture condition. *Journal of basic microbiology* 49: 433-440.

European paper and packaging industries. 2014. Retrieved 16 October 2014 from http://www.paperonline.org/paper-making/paper production/ pulping/production/pulping/pulping-properties-of-hardwoods-and-softwood.

Eriksson, K., Blanchette, R.A and Ander, P., 1990. *Microbial and enzymatic degradation of wood and wood components*. New York: Springer-Verlag. pp. 397.

Esposito, E., Innocentini-Mei, L.H. Ferraz. A., Canhos, V.P. and Duran, N. 1993. Phenoloxidases and hydrolases from *Pycnoporus sanguineus* (UEC-2050 strain): applications. *Journal Biotechnology* 29: 219-228.

Fackler, K., Gradinger, C., Hinterstoisser, B., Messner, K. and Schwanninger, M. 2007. Lignin degradation by white rot fungi on spruce wood shavings during short-time solid-state fermentations monitored by near infrared spectroscopy. *Enzyme and Microbial Technology* 39: 1476-1483.

FAO, Forestry Statistic Team. 2010. Committee on forestry 2010. Retrieved May 2013 from http://www.youtube.com/watch?v=wPN4C39E3A4&feature=BF&list=PL795DE0AA91EA9BE7&index=41/.

Faria, H., Cordeiro, N., Belgacem, M.N. and Dufresne, A. 2006. Dwarf Cavendish as a source of natural fibers in poly (propylene)-based composites. *Macromolecular Material and Engineering* 291:16–26

Fatriasari, W., Anita, S.H., Falah, F., Adi, T.N. and Hermiati, E. 2010. Biopulping of betung bamboo using white rot fungi (*P.ostreatus* and *T.versicolor*) with kraft and soda processes. *Jurnal Ilmu Kayutropis* 45(2): 44-56.

Feng, Z. and Alén, R.J. 2001. Soda AQ pulping of wheat straw. *Appita Journal* 54(2):217-220.

Ferraz, A., Guerra, A., Mendonca, R., Masarin, F., Vicentim, M.P., Aguiar, A. and Pavan, P.C. 2008. Technological advances and mechanistic basis for fungal biopulping. *Enzyme and Microbial Technology* 43:178–185.

Fillat, U. and Blanca Roncero, M. 2009. Biobleaching of high quality pulps with laccase mediator system: influence of treatment time and oxygen supply. *Biochemical Engineering Journal* 44(2-3): 193-198.

Fillat, U., Prieto, A., Camarero, S., Martínez, A.T and Martínez, M.J. 2012. Biodeinking of flexographic inks by fungal laccases using synthetic and natural mediators. *Biochemical Engineering Journal* 67: 97-103.

Findlay, W.P.K. 1958. *Timber properties and uses*. London: Mc Millan Co. pp 224.

Fonseca, M.I., Shimizu, E., Villalba, L.L., Zapata, P.D., 2010. Laccase-producing ability and the inducing effect of copper on laccase production of white rot fungi native from Misiones (Argentina). *Enzyme Microbial Technology* 46: 534-539.

Fonseca, M.I., Zapata, P.D., Villalba, L.L. and Farina, J.I. 2014. Characterization of the oxidative enzyme potential in wild white rot fungi from Misiones (Argentina). *Acta Biologica Columbiana* 20(1): 47-56.

Fontanier, V., Farines, V., albet, J., Baig, S. and Molinier, J. 2006. Study of catalysed ozonation for advanced treatment of pulp and paper mill effluents. *Water Research* 40: 303-310.

Fujita, K., Kondo, R., Sakai, K., Kashino, Y., Nishida T. and Takahara, Y. 1993. Biobleaching of softwood Kraft pulp with white rot fungus IZU-154. *Tappi Jornal* 76: 81-84.

Ganan, P., Zuluaga, R., Velez, J. M. and Mondragon, I. 2004. Biological natural retting for determining the hierarchical structuration of banana fibers. *Macromolecular Bioscience* 4: 978-983.

Gervais, P. and Molin, P. 2003. The role of water in solid-state fermentation. *Biochemical Engineering Journal* 13(2): 85-101.

Giles, L.R., Zackeru, C.J., Elliott, D.G. and Parrow, W.M. 2012. Fungal growth necessary but not sufficient for effective biopulping of wood for lignocellulosic ethanol applications. *International Biodeterioration and Biodegradation* 67: 1-7.

Gong, H.R. 2007. Wood characteristic and storage methods of poplar residue. *China wood-based panel* 14(3): 29-30.

Goswami, T., Kalita, D. and Rao, P.G. 2008. Greaseproof paper from banana (*Musa paradisica* L.) pulp fibre. *Indian Journal of Chemical Technology* 457-461.

Guerra, A., Mendoca, R., Ferraz, A., Lu, F. and Ralph, J. 2004. Structural characterization of lignin during *Pinus Taeda* wood treatment with *Ceriporiopsis subvermispora. Applied Environmental Microbiology* 70(7): 4073-4078.

Guha, S.R.D. 1960. Kraft paper from banana stems. *India Pulp and Paper* 15(5): 311-315.

Gümuüşkaya, E. and Usta, M. 2002. Crystalline structure properties of bleached and unbleached wheat straw (*Triticum aestevum L*.) soda–oxygen pulp. *Turkey Journal of Agriculture Forestry* 26(5): 247-252.

Gupta, R., Bhatt R.P., Thapliyal, B.P., Naithani, S. and Saini, V.K. 2012. Influences of growth parameters on bio delignification of *Eucalyptus tereticornis* by *Schizophyllum commune*. *Journal of advanced scientific research research* 3(1): 95-99.

Halis, R., Tan, H.R., Ashaari, Z. and Mohamad, R. 2012. Biomodification of Kenaf chip using white rot fungi. *Bioresources* 7(1): 984-87.

Hamed, S.A.M. 2013. In-vitro studies on wood degradation in soil by soft-rot fungi: *Aspergillus niger* and *Penicillium chrysogenum*. *International Biodeterioration & Biodegradation* 78: 98-102.

Han, J.S., Miyashita, E.S. and Spielvogel, S.J. 1999. Properties of kenaf from various cultivars, growth and pulping conditions. In *Kenaf Properties, Processing and Products,* Mississipi State University, *Agriculture and Bio Engineering* 1999, pp 267-283.

Heikal, S.O. 1976. Nitric acid paper pulps from banana stems. *India pulp and Paper* 31(3): 5-7.

Hergert, H.L. 1998. Developments in organosolv pulping. *In Environmental Friendly Technologies for the Pulp and Paper Industry*, Ed. R.A. Young, M. Akhtar, pp. 5–67. New York: Wiley.

Hon, D.N.S. 1994. Cellulose: a random walk along its historical path. *Cellulose* 1: 1–25.

Hong, L.S., Ibrahim, D. and Omar, I.C. 2011. Lignocellulolytic materials as raw materials for the production of fermentable sugars. *Asian Journal of Scientific Research* 4: 53-61.

Hong, B., Xue, G., Weng, L. and Guo, X. 2012. Pretreatment of Moso Bamboo with dilute phosphoric acid. *Bioresources* 7(4): 4902-4913.

Hunt, C., Kenealy, W., Horn, E. and Houtman, C. 2004. A biopulping mechanism creation of acid groups on fibre. *Holzfors-chung* 58: 434–439.

Hurter, A.M. 1988. In *Utilization of Annual Plants and Agricultural Residues for the Production of Pulp and Paper*. Proceeding of TAPPI Pulping Conference, Oct. 30–Nov. 2, 1988. New Orleans, L.A. (Ed.); Book 1, TAPPI Press, Atlanta, GA, p.139–160.

Hurter, N. 2006. Nonwood plant fibre characteristic. Retrieved 7 May 2012 from http://www.hunterconsult.com/nonwood_characteristics.htm.

Husaini, A., Fisol, F.S., Yun, L.C., Hussain, M.H. and Roslan, H.A. 2011. Lignocellulolytic enzymes produced by tropical white rot fungi during biopulping of *Acacia mangium* wood chips. Journal of Biochemical Technology 3(2): 245-50.

Ince, B.K., Cetecioglu, Z. and Ince, O. 2011. Pollution Prevention in the Pulp and Paper Industries. Retrieved 6 Nov 2012 from http://www.intechopen.com/books/environmentalmanagement-inpractice/pollution-prevention-in-the-pulp-and-paper-industries

Intergovernmental Panel on Climate Change (IPCC). 2014. The Fifth Assessment Report. Retrieved 14 April 2013 from https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf

International Energy Agency (IEA). 2012. Key World Energy Statistics. Retrieved 14 April 2013 from http://www.iea.org.

Isenberg, I.H. 1962. Fibrous raw materials and wood structure. In *Pulp and Paper Science and Technology.* New York: McGraw-Hill Book Company.

Islam, M., Karim, N.M. and Malinen, R.O. 2008. Beneficial effects of fungal treatment before pulping and bleaching of *Acacia mangium* and *Eucalyptus camaldulensis. Turkish Journal of Agriculture and Forestry* 32 (4): 331-38.

Islam, M., Karim, N.M. and Malinen, R.O. 2008. Beneficial effects of fungal treatment before pulping and bleaching of *Acacia mangium* and *Eucalyptus camaldulensis*. Turkey Journal of Agriculture Forestry 32: 331-38.

Istek, A., Sivrikaya, H., Eroglu, H. and Gulsoy, S.K. 2005. Biodegradation of *Abies bornmulleriana* (Mattf.) and *Fagus orientalis* (L.) by the white rot fungus *Phanerochaete chrysosporium. International biodeterioration and biodegradation* 55:63-67.

Jacobs, R.S., Pan, W.L., Fuller, W.S., and MsKean, W.T. 1999. In *Genetic and Environmental Influences on the Chemical Composition of Washington State wheat straw*. Proceedings of the TAPPI Pulping Conference, Oct. 31–Nov. 4, 1999. Orlando, F.L. (Ed.); TAPPI Press, Atlanta, GA, 2:839-846.

Jahan, M.S., Chowdhury, D.A.N. and Islam, M.K. 2007. Atmospheric formic acid pulping and TCF bleaching of dhaincha (*Sesbania aculeata*), kash (*Saccharum spontaneum*) and banana stem (*Musa Cavendish). Industrial Crops and Products* 26: 324-331.

Jean-Marc, R. and Santosh R. 2006. Feeding China's Expanding Demand for Wood Pulp: A diagnostic assessment of plantation development, fiber supply, and impacts on natural forests in China and in the South East Asia Region. Jakarta, Indonesia: Center for International Forestry Research.

Johansson, A. 2011. *Correlations between fibre properties and paper properties*, Mater thesis in Pulp Technology.

Juan, C.C. and Victor O. 2011. Green technology: Last developments in enzymes for paper recycling. *VH Biotechnolgy, Inc*: 1630-1639.

Justiz-Smith, N.G., Junior virgo, G. and Buchanan, V.E. 2008. Potential of Jamaican banana, coconut coir and bagasse fibres as composite materials. *Materials characterization* 59(9): 1273-1278.

Kadam, A.A., Telke, A.A., Jagtap, S.S.and Govindwar, S.P. 2011. Decolorization of adsorbed textiles dyes by developed consortium of *Pseudomonas* sp. SUK 1 and *Aspergillus ochraceus* NCIM-1146 under solid state fermentation. *Journal of Hazard Material* 189: 486-494.

Karat, I. 2013. 1. *Advanced Oxidation Processes for Removal of COD from Pulp and Paper Mill Effluents A Technical, Economical and Environmental Evaluation*. Master Thesis, Royal Institute of Technology, Stockholm.

Karimi-Jashni, A, Kheradmand, S. and Sartaj, M. 2010. Treatment of municipal landfill leachate using a combined anaerobic digester and activated sludge system. *Waste Management* 30(6): 1025–1031.

Kasetsart, J. 2005. The physical properties, fiber morphology and chemical compositions of sweet bamboo (*Dendrocalamus asper Backer*). *National science* 39: 581-587.

Khalil, A.H.P., Alwani, M.S. and Omar, A.K.M. 2006. Chemical composition, anatomy, lignin distribution, and cell wall structure of Malaysian waste fibres. *Bioresources* 1(2): 220-32.

Kim, T.J., Ow, S.S.K. and Eom, T.J. *Enzymatic deinking method of waste paper.* TAPPI pulping conference, 2005. Orlando, F.L. (Ed.).

Kirk, T.K., Harkin, J.M. and Cowling, E.B. 1968. Degradation of the lignin model compound syringylglycol fl-guaiacytether by *Polyporous versicolor* and *Stereum trustulatum*. *Biochemical Biophysical Acta* 165:145-163.

Kirk, T.K., Koning, J.W., Burgess, R., Akhtar, M., Blanchette, R., Cameron D.C., Cullen, D., Kerstin, P., Lightfoot, E.N., Mayers, G., Sykes, M.B. and Wall, M.B. 1993. Biopulping a glimpse of the future. Research Paper, FPL–RP–523, Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Pp. 74.

Klemn, D., Heublein, B., Fink, H.P. and Bohn, A. 2005. Cellulose: Fascinating biopolymer and sustainable raw material. *Angewandte Chemie* 44: 3358-3393.

Kole, C. (Ed) (2012); Genetics, genomics and breeding of bananas. Taylor & Francis Group, LLC, 282-301 p.

Krull, R., Cordes, C., Horn, H., Kampen, I., Kwade, A., Neu, T.R. and Nörtemann, B. 2010. Morphology of filamentous fungi: linking cellular biology to process engineering using *Aspergillus niger* Advances in *Biochemical Engineering/Biotechnology* 121: 1–21.

Kulkarni, H.D. 2013. Pulp and paper industry raw material scenario- ITC plantation a case study. *Ippta journal* 25(1): 79-89.

Kumar, A.G., Sekaran, G. and Krisnamoorthy, S. 2006. Solid fermentation of *Achras zapota* lignocellulose by *Phanerochaete chrysosporium. Bioresources technology* 97: 1521-1528.

Laftah, W.A. and Abdul Rahaman, W.A.W. 2015. Chemical pulping of waste pineapple leaves fiber for kraft paper production. *Journal of Materials Research and Technology.* Article in press: http://dx.doi.org/10.1016/j.jmrt.2014.12.00

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

Levin, L., Villalba, L., Da re, V., Forchiassin, F. and Papinutti, L. 2007. Comparative studies of loblolly pine biodegradation and enzyme production by Argentinean white rot fungi focused on biopulping processes. *Process Biochemistry* 42: 995-1002.

Levin, L., Melignani, E. and Ramos, A.M. 2010. Effect of nitrogen sources and vitamin on ligninolytic enzyme production by some white-rot fungi. Dye decolorization by selected culture filtrates. *Bioresource Technology* 101(12): 4554-4563.

Lewis D.S. 2003. A comparison of pulping and bleaching of kraft softwood and eucalyptus pulps. *36th international pulp and paper congress and exhibition*.

Li, A., Zhu, Y., Xu, L., Zhu, W. and Tian, X. 2008. Comparative study on the determination of assay for laccase of *Trametes sp*. *African Journal of Biochemical Research* 2(8): 181-83.

Li, K., Shiyu, F., Huaiyu, Z., Yao, Z. and Lucian, A.L. 2010. Analysis of the chemical composition and morphological structure of banana pseudo-stem. *Bioresources* 5(2): 576-85.

Liang, X., Huang, Y., Hua, D., Zhang, J., Xu, H., Li, Y. and Zhang X. 2012. Cellulase production by *Aspergillus* sp. on rice grass (*Spartina* spp.) under solid-state fermentation. *African Journal of Microbiology Research* 6(39) 6785–6792.

Lifshitz, L. 2013 Market Forecast Paper Industry Outlook for 2013. . Retrieved 30 September 2014 from http://www.pffc-online.com/flexpack/substrates/11025-market-forecast-paper-industry-outlook-for-2013.

Liu, B.Y., Shi, H.Q., Li, X.Q. and Xu, L.Q. 2003. Analysis of lignin content in waste liquor of rice straw pulp by ultraviolet spectrophotometer. *China pulp and paper industry* 22(6): 19-22.

Lomascolo, A., Uzan-Boukhris, E., Herpoël-Gimbert, I., Sigoillot, J.C. and Lesage-Meessen, L. 2011. Peculiarities of *Pycnoporus* species for applications in biotechnology. *Applied Microbiology and Biotechnology* 92(6): 1129-149.

López, F., Pérez, A., García, J., Feria, M., García, M. and Fernández, M. 2011. Cellulosic pulp from Leucaena diversifolia by soda-ethanol pulping process. *Chemical Engineering Journal* 166: 22-29 Latorre, U.F., Sacon, V.M. and Bassa, A. Selection of commercial xylanases to improve pulp bleaching in Jacarei mill. In *Influence of pH and COD in process efficiency.* International pulp bleaching conference, Quebec City, Canada, June. 2-5, 2008.

Low, J.C., Halis, R., Umi Kalsom, M.S., Paridah, M.T., Faizah, A. Tuhaila, T. Danial, M.I., Lakarim, L. and Norhaslida, R. 2015. Enhancing Enzymatic Digestibility of Alkaline Pretreated Banana Pseudostem for Sugar Production. *Bioresources* 10(1): 1213-1223.

Maijala, P., Kleen, M., Westin, C., Poppius-Levlin, K., Herranen, K., Lehto, J.H., Reponen, P., Mäentausta, O., Mettala, A. and Hatakka, A. 2008. Biomechanical pulping of softwood with enzymes and white-rot fungus *Physisporinus rivulosus. Enzyme and Microbial Technology* 43(2): 169–177.

Manimaran, A. and Vatsala, T.M. 2007. Biobleaching of banana fiber pulp using *Bacillus subtilis* C o1 xylanase produced from wheat bran under solid-state cultivation. *Journal Industrial Microbilogy Biotechnology* 34: 745-749.

Mao, Y., Li, J., Li, S., Chang, S. and Zhao, G. 2015. The mass transfer of sugar in sweet sorghum stalks for solid-state fermentation process. Fuel 144a: 90-95.

Martínez, A.T., Rencoret, J., Nieto, L., Jiménez-Barbero, J., Gutiérrez, A., José, C., Watanabe, R., Baldrian, P. and Valaskova, V. 2011. Selective lignin and polysaccharide removal in natural fungal decay of wood as evidenced by in situ structural analyses. Environmental Microbiology 13(1): 96–107.

Mcdonald, R.G. 1969. *The pulping of wood.* New York: McGraw-Hill. pp. 262-264.

Mendonça, R.T., Jara, J.F., González, V., Elissetche, J.P. and Freer, J. 2002. Evaluation of the white-rot fungi *Ganoderma austral* and *Ceriporiopsis subvermispora* in biotechnological applications. *Journal of Industrial Microbiology and Biotechnology* 35(11): 1223-1230.

Messer, K. and Srebonik, E. 1994. Biopulping: An overview of developments in an environmentally safe paper-making technology. *FEMS Microbiology Review* 13: 35-364.

Mitchell, D.A., Berovic, M. and Krieger, N., 2006. Solid-state fermentation bioreactor fundamentals: introduction and overview. In *In Solid-State Fermentation Bioreactors*, pp. 1–12. Berlin, Heidelberg: Springer.

Mocchlutti, P., Maria, V.G., Maria, C.I. and Miguel, A.Z. Improvement of paper properties of recycled unbleached softwood kraft pulp by Poly (Allylamine hydrochloride). *Bioresoures* 2011 6(1): 570-83.

Mohamad Roff, M.N., Tengku Abdul Malik, T.M., and Sharif, H. 2012. Challenges to banana production in Malaysia: A threat to food security. *The Planter Kuala Lumpur* 88(1030): 20-30.

Mohammed, S.H. 2010. Enzymatic deinking: a bright solution with bright future. *IPPTA* 22(3): 137-138.

Mohapatra, D., Mishra, S. and Sutar, N. 2010. Banana anf its by-product utilisation: an overview. *Journal of Scientific and Industrial Research* 69: 323-329.

Monrroya, M., Ortega, I., Ramírez, M., Baezaa, J. and Freer, J. 2011. Structural change in wood by brown rot fungi and effect on enzymatic hydrolysis. *Enzyme and Microbial Technology* 49(5): 472–477.

Ncube, T., Howard, R., Abotsi, E.K., van Rensburg, E.L.J. and Ncube, I. 2012. Jatropha curcas seed cake as substrate for production of xylanase and cellulase by *Aspergillus niger* FGSCA733 in solid-state fermentation. *Industrial Crops and Products* 37(1): 118–123.

Nieschlag, H.J., Nelson, G.H., Wolff, J.A. and Perdue, R.E. 1960. A search for new fibre crops. *Tappi Journal* 43(3): 193.

Norhaslida, R., Halis, R., Lakarim, L., Danial, M.I., Low, J. and Naimah, M.S. 2014. Chemical alteration of banana pseudostem by white rot fungi. *Biomass and Bioenergy* 61: 206-210.

Ogunsile, B.O., Omotoso, M.A. and Onilude, M.A. 2006. Comparative soda pulps from the mid-rib, pseudostem and stalk of Musa paradisiaca. *Journal of Biological Sciences* 6(6): 1047-1052.

Oinonen, H. and Koskivirta, M. 1999. In *Special Challenges of Pulp and Paper Industry in Asian Populated Countries, like Indian Sub-continent and China.* Proceedings of the Paperex 99-4th International Conference on Pulp and Paper Industry: Emerging Technologies in the Pulp and Paper Industry, Dec. 14-16, 1999. New Delhi, India, p. 49–68

Oluwadare, A.O. and Ashimiyu S.O. 2007. The relationship between fibre characteristics and pulp-sheet properties of *Leucaena leucocephala* (Lam.) De Wit. *Middle-East Journal of Scientific Research* 2(2): 63-68.

Omotoso, M.A. and Ogunsile, B.O. 2009. Fibre and Chemical Properties of Some Nigerian Grown Musa Species for Pulp Production. *Asian Journal of Materials Science* 1: 14-21.

Paavilainen, L. 1993. Wet conformability- Flexibility and collapsibility of sulphate pulp fibres. *Paperi Ja Puu* 75(9-10): 689-702.

Paavilainen, L. 2000. *Quality competitiveness of Asian short-fiber raw materials in different paper grades*. *Paperi Ja Puu* 82(2): 156–161.

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

Pascoal Neto, C., Seca, A., Nunes, A.M., Coimbra, M.A., Domingues, F., Evtuguin, D., Silvestre, A. and Cavaleiro, J.A.S., 1997. Variations in chemical composition and structure of macromolecular components in different morphological regions and maturity stages of *Arundo donax*. *Industrial Crops Products* 6: 51-58.

Peh, T.B., Wong, W.C., Low, C.K. and Khoo, K.C. 1986. The fibre morphology of some Malaysia hardwoods. *The Malaysian Forester* 49(2): 160-175.

Pensupa, N., Jin, M., Kokolski, M., Archer, D.B. and Du, C. 2013. A solid state fungal fermentation-based strategy for the hydrolysis of wheat straw. *Bioresoures Technology* 149: 261-267

Perez, J., Munoz-Dorado, J., de ls Rubia, T. and Martinez, J. 2002. Biodegradation and biological treatments of cellulose, hemicellulose and lignin: an overview. *International Microbiology* 5: 53-63.

Pérez, J., Muñoz-Dorado, J., De-la-Rubia, T. and Martínez, J. 2002. Biodegradation and biological treatments of cellulose, hemicellulose and lignin: an overview. International Microbiology 5: 53–63.

Pillay, M. and Tripathi, L. Banana: An overview of breeding genomics research in *Musa.* In *Genome Mapping and Molecular Breeding in Plants.* Ed. C Kole. Heideberg: Srinnger-Verlag. 2006.

Pointing, S.B., Parungao, M.M., and Hyde, K.D. 2003. Production of wood decay enzymes, mass loss and lignin solubility in wood by tropical Xylariaceae. *Mycology Resources* 107(2): 231-235.

Polizeli, M.L.T.M., Rizatti, A.C.S., Monti, R., Terenzi, H.F., Jonge, J.A. and Amorim, D.S. 2005. Xylanases from fungi: properties and industrial application. *Applied Microbiology and Biotechnology* 67: 577-591.

Punnet, P., Bhardwaj, N.K. and Singh, A.K. 2010. Enzymatic deinking of office waste paper: an overview. *IPPTA* 22(2): 83-88.

Putz, H.J. 2006. Recovered paper and recycled fibers. In *Handbook of Pulp,* ed. H. Sixta, pp. 1147-1203. KGaA, Weinheim: Wiley-VCH Verlag GMbH & Co.

Raimbault, M. 1998. General and microbiological aspects of solid substrate fermentation. *Electronic Journal of Biotechnology* 1(3): 1-15.

Ramos, J., Gonzalez, M., Ramirez, F., Young, R. and Zuniga, V. 2001. Biomechanical and biochemical pulping of sugarcane bagasse with *Ceririopsis subvermispora* fungal and xylanase pretreatments. *Journal Agriculture Food Chemistry* 49(3): 1180-1188.

Rasheed, S. and Dasti, A.A. 2003. Quality and mechanical properties of plant commercial fibers. *Pakistan Journal of Biological Science* 6(9): 840-843.

Rasmina, H. 2010. *Optimization of Kraft and Biokraft Pulping for Kenaf V36*, PhD Thesis, Universiti Putra Malaysia.

Rasmina, H., Naimah, M.S., Aziah, H., Kiew, Y.N. and Konami, Y. 2011. Retting of Musa sapientum Pseudostem with Pectin Decomposting Bacteria. *Journal of Agricultural Science and Technology* 1(8): 1238-1244.

Reddy, N., and Yang, Y. 2005. Biofibers from agricultural byproducts for industrial applications. *Trends in Biotechnology* 23: 22 – 27.

Reinaa, L., Galettaa, A., Vinciguerra V.B., Resquinc, F. and Menéndez P.A. 2014. The relationship between Eucalyptus grandis lignin structure and kraft pulping parameters. *Journal of Analytical and Applied Pyrolysis* 107: 284-288.

Renuka, P.S., More, S.S., Pruthvi, K., Swetha, M., Malini, S. and Veena, S. M. 2011. Isolation, Purification and Characterization of Fungal Laccase from *Pleurotus sp*. Enzyme Research Article ID 210061. Hindawi Publishing Corporation.

Rezayati-Charani, P., Mohammadi-Rovshandeh, J., Hashemi, S.J. and Kazemi-Najafi, S. 2006. Influence of dimethyl formamide pulping of bagasse on pulp properties. *Bioresources Technology* 97(18): 2435-2442.

Risi- Pulp and paper, wood product and timber conference. 2014. RISI 2014 Annual Review of Global Pulp & Paper Statistics. Retrieved 24 February 2015 from http://www.risiinfo.com/pulp-paper/ppippw/Reports-RISI-2014-Annual-Review-of-Global-Pulp-Paper-Statistics-Global-Pellet-Demand-Outlook.html

Roberts, J.C. 1996. *The chemistry of paper*. Cambridge: The royal society of chemistry. Pp. 190.

Robinson, T., Singh, D and Nigam, P. 2001. Solid-state fermentation: a promising microbial technology for secondary metabolite production Applied Microbiology and Biotechnology 55(3): 284-289.

Roda, J-M. and Rathi, S. 2006. Feeding China's Expanding Demand for Wood Pulp: A Diagnostic Assessment of Plantation Development, Fiber Supply, and Impacts on Natural Forest in China and in the South East Asia Region (Malaysia report), Asia Pro Eco Program, Published by Centre of International Forestry Research (CIRAD), Jakarta. Pp 1-65.

Roger, C.P. 1984. The chemical composition of wood. *U.S. Department of Agriculture,* American Chemical Society.

Roriz, M.S., Osma, J.F., Teixeira, J.A. and Couto, S.R. 2009. Application of response surface methodological approach to optimize Reactive Black 5 decolouration by crude laccase from *Trametes pubescens*. *Journal of Hazardous Materials* 169 (1-3): 691–696.

Rosli, H.M., Farid, A.M., Lee, S.S., Azril, D.M.D., Baharudin, K., Norlida B., Norwati, A. and Norwati, M. 2008. Efficiency of wood degradation of ten selected isolates of white-rot fungi. *Highlights of FRIM's MOSTI Projects 2007,* 82-84.

Rowell, R.M., Han, J.S., and Bisen, S.S. 1997. Changes in fiber properties during the growing season. In *Paper and Composites from Agro-Based Resources*, ed. R.A. Young, & J.K. Rowell, pp. 23-28. Florida: USA: CRC Lewis Publishers Boca Raton.

Rozi, M., Min, T.L. and Rasmina, H. 2013. Biodegrading ability and enzymatic activities of some white rot fungi on Kenaf (*Hibiscus cannabinus*). *Sains Malaysiana* 42(10): 1365–1370.

Runkel, R. 1940. Wochbl. Papierfabr. 71(9): 93. In *Using Confocal Microscopy to Characterize the Collapse behaviour of Fibres,* ed. H.F. Jang and R.S. Seth. *Tappi Journal* 81(5): 167-174.

Runkel, R. 1949. Cellulose. *Chemistry and Technology* 32: 133.

Sadhasivam, S., Savitha, S., Swaminathan, K. and Lin H.S. 2008. Production, Purification, Characterization of mid redox potential laccase from newly isolated *Trichoderma harzianum* WL1. *Process Biochemistry* 43: 736-742.

Saheb, N.D. and Jog, J.P. 1999. Natural fiber polymer composites: A review. *Advances in Polymer Technology* 18: 351-363.

Sahin, H.T. 2003. Base-catalyzed organosolv pulping of jute. *Journal of Chemical Technology and Biotechnology* 78(12): 1267-1273.

Saleem, A. and Ebrahim, M.K.H. 2014. Production of amylase by fungi isolated from legume seeds collected in Almadinah Almunawwarah, Saudi Arabia. *Jornal of Taibah University for Science* 8(2): 90-97.

Salmela, M., Alen, R. and Hong Vu, M.T. 2008. Description of kraft cooking and oxygen-alkali delignification of bamboo by pulp and dissolving material analysis. *Industrial Crops and products* 28(1): 47-55.

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

Savcor, I.O, *Technical assistant for the sustainable development of the non-wood pulp and paper industries*. Conclusion report, Pulp quality comparison. China. 2007.

Schmidt, O. 2006. *Wood and tree fungi: biology, damage, protection, and use*. Berlin: Springer-Verlag. pp. 346.

Schwarze, F. 2007. Wood decay under the microscope. *Fungal biology reviews* 21: 133-170.

Scott, G.M., Sykes, M., Abubakr, S., Akhtar, M. and Lentz, M. 1995. *Environmental Aspects of Biosulfite pulping.* USDA.

Severine, S., Chaussy, D., Mauret, E., Isabelle, D., Antunes, A., Nereida, C. and Mohamed, N.B. 2003. Valorization of different agricultural crops in papermaking application. *Papermaking Science and Technology Journal* 41: 274-283.

Shah, M.P., Reddy, G.V., Banerjee, R., Ravindra Babu, P. and Kothari, I.L. 2005 Microbial degradation of banana waste under solid state bioprocessing using two lignocellulolytic fungi (*Phylosticta spp.* MPS-001 and *Aspergillus spp.* MPS-002). *Process Biochemistry* 40(1): 445–451.

Shakhes, J., Zeinaly, F., Marandi, A.B.M. and Saghafi, T. 2011. The effects of processing variables on the soda and soda-aq pulping of kenaf bast fibre. *Bioresoures* 6(4): 4626-4639.

Sharma, P., Sood, C., Singh, G. and Capalash, N. 2015. An eco-friendly process for biobleaching of eucalyptus kraft pulp with xylanase producing *Bacillus halodurans*. *Journal of Cleaner Production* 87: 966-970

Shraddha, R.S., Sehgal, S., Kamthania, M. and Kumar, A. 2011. Laccase: Microbial sources, production, purification, and potential biotechnological applications. Enzyme research article ID 217861, Hindawi Publishing Corporation.

Shukla, O.P., Rai, U.N. and Subramanian, S.V. 2004. Biopulping and biobleaching. An energy and environment saving technology for Indian pulp and paper industry. Environ News Lett, ISEB, Lucknow, vol 10, no 2, April 2004.

Singh, P., Sulaiman, O., Hashim, R., Rupani, P F., Peng, L.C. 2010. Biopulping of lignocellulosic material using different fungal species: a review. *Reviews Environmental Science and Biotechnology* 9(2): 141-151.

Singh, P., Sulaiman, O., Hashim, R., Peng, L.C and Rajeev Singh, R.P. 2012. Biodegradation study of pycnoporus sanguineus and its effects on structural and chemical features on oil palm biomass chips. *Lignocellulose* 1(3): 210-227.

Singh, P., Othman, S., Rokiah, H., Leh, C.P. and Rajeev, P.S. 2013. Evaluating biopulping as an alternative application on oil palm trunk using the white-rot fungus *Trametes versicolor. Bioresources* 82: 96-103.

Singhal, A., Jaiswal, P.K., Jha, P.K., Thapliyal, A. and Thakur, I.S. 2013. Assessment of *Cryptococcus albidus* for biopulping of Eucalyptus. *Prep Biochemical and Biotechnology* 43: 735-749.

Singhal, A., Jaiswal P.K. and Thakur, I.S. 2015. Biopulping of bagasse by *Cryptococcus albidus* under partially sterilized conditions. *International Biodeterioration & Biodegradation* 97: 143-150.

Singhaniaa,R.R., Patelb, A.K., Soccolc, C.R and Pandey, A. 2009. Recent advances in solid-state fermentation. *Biochemical Engineering Journal* 44: 13-18.

Sixta, H. 2006. Handbook of pulp. Wiley-VCH Verlag GMbH & Co.

Smook G.A. 1992. *Handbook of pulp and paper technologist*. Vancouver: Angua wilde publications. pp. 419.

Smook, G.A. *Handbook for Pulp and Paper Technology*; 3rd ed.; TAPPI Press: New York. 2003.

Spearin, W.E. and Isenberg, I.H. 1947. Science 105: 214. In *Contribution of Hardwood fibres to The Properties of Kraft Pulps,* ed. F.F. Wangaard, 1962, *Tappi* 45(7): 548-556.

Spiridon, I. and Balgacem, M.N. 2004. Enzymatic deinking of laser printed papers. *Progress in Paper Recycling* 13(4): 12.

Spiridon, I. and de Andrade, A.M. 2005. Enzymatic deinking of old newspaper (ONP). *Progress in Paper Recycling* 14(3): 14

Sridach, W. 2010. The environmentally benign pulping process of non-wood fibers. *Suranaree Journal of Science and Technology* 17(2): 105-123.

Stajić, M., Persky, L., Friesem, D., Hadar, Y.,Wasser, S. P. Nevo, E. and Vukojenik, J. 2006. Effect of different carbon and nitrogen sources on laccase and peroxidases production by selected *Pleurotus* species. *Enzyme and Microbial Technology* 38(1-2): 65-73.

Subrahmanyan, V., and Siddappa, G.S. 1963. Utilization of cellulosic agricultural wastes: pulps from banana pseudostems and areca husks. *India pulp and Paper* 17(8): 533-536.

Svenningsen, N., Visvanathan, C., Malinen, R., and Patankar, M. 1999. Cleaner product in the pulp and paper industry: Technology fact sheets. Asian Institute of Technology and the United Nations Environment Programme (UNEP). Pathumtani, Thailand, p. 1-35.

Szabóa, L., Soriaa, A., Forsströmb, J., Keränenb, J.T. and Hytönenb, E. 2009. A world model of the pulp and paper industry: Demand, energy consumption and emission scenarios to 2030. *Environmental Science & Policy* 12(3): 257-269.

Talaeipour, M., Hemmnasi, A.H., Kasmani, J., Mirshokreie, E. and Khademieslan, H. 2010. Effects of fungal treatment on structural and chemical features in horn bean chips. *Bioresources* 5(1): 477-87.

Tan, H.R. 2013. Biomodification of kenaf by white rot fungi. Unpublished master thesis, University Putra Malaysia.

TAPPI Test Methods, 2002. Tappi Press: Atlanta, GA.

Temp, U. and Eggert, C., 1999. Novel inetraction between laccase and cellobiose dehydrogenase during pigment synthesis in the white rot fungus *Pycnoporus cinnabarinus*. *Applied and Environmental Microbiology* 65: 389-395.

Tian, X.F., Fang, Z. and Guo, F. 2012. Impact and prospective of fungal pre-treatment of lignocellulosic biomass for enzymatic hydrolysis. *Biofuels and Bioproduct Biorefinery* 6: 335-350.

Todd, W.G., 1972. Water deficits and enzymatic activity. In *Plant Response and Control of Water Balance,* ed. T.T. Kozlowski, pp. 117–216. New York: Academic Press.

Tsoumis, G. 1991. *Science and technology of wood: structure, properties and utilization.* New York: Van Nostrand Reinhold.

Ulhoa, C.J. 1986. *The Study of the Cellulolytic Complex of Pycnoporus sanguineus,* Master thesis, University of Brasolia, Brazil.

Uma, S., Kalpana, S., Sathiamoorthy, S. and Kumar, V. 2005. Evaluation of commercial cultivars of banana (*Musa* spp.) for their suitability for the fibre industry. *Plant Genetic Resources Newsletter* 142: 29-35.

Van Beek, T.A., Kuster, B., Claassen, F.W., Tienvieri, T., Bertaud, F., Lenon, G., Petit Conil, M. and Sierra-Alvarez, R. 2007. Fungal bio-treatment of spruce wood with *Trametes versicolor* for pitch control: Influence on extractive contents, pulping process parameters, paper quality and effluent toxicity. *Bioresorces Technology* 98(2): 302-11.

Vicentim, M.P. and Ferraz, A. 2007. Enzyme production and chemical alterations of Eucalyptus grandis wood during biodegradation by *Ceriporiopsis subvermispora* in cultures supplemented with Mn2+, corn steep liquor and glucose. *Enzyme and Microbial Technology* 40: 645-652.

Viikari, L., Tenkanen, M., Bucher, J. et al. 1993. In *Bioconversion of Forest and Agricultural plant Residues,* ed. J.N. Saddler, pp. 131. Oxford: CAB International.

Viikari, L., Suurna, K.K.I., Gronqvist, S., Raaska, L. and Ragaukas, L.A. 2009. *Forest Product: Biotechnology in Pulp and Paper Processing, encyclopedia of microbiology.* Elsevier.

Vikineswary, S., Abdullah, N., Renuvathani, M., Sekaran, M., Pandey, A. and Jones, E.B.G. 2006. Productivity of laccase in solid substrate fermentation of selected agro-residues by *Pycnoporus sanguineus. Bioresources technology* 97(1): 171-177.

Wagberg, L., & Annergern, G.O. 1997. Physicochemical characterization of papermaking fibres, In *The Fundamentals of Papermaking Materials*. Transaction of the 11th Fundamental Research Symposium, Cambridge, Pira International. C.F. Baker (Ed.).

Welt, T. and Dinus, R.J. 1995. Enzymatic deinking: a review. *Progress in Paper Recycling* 4(2): 36.

Wolfaardt, F., Taljaard, J.L., Jacobs, A., Male, J.R. and Rabie, C.J. 2004. Assessment of wood-inhabiting basidiomycete for biokraft pulping of softwood chips. *Bioresource technology* 95: 25–30.

Wolfe, J. and Steponkus, P.L., 1983. Tension in the plasma membrane during osmotic contraction. *Cryobiology* 4: 315–322.

Wong, A.H.H., Kim, Y.S., Singh, A.P. and Ling, W.C. 2005. Natural durability of tropical species with emphasis on Malaysia hardwoods- Variation and prospects. International Research Group on Wood Protection. Bangalore: IRG.

Wu, C., Chien, S., Wang, S., Kuo, Y. and Chang, S. 2005. Structure- activity relationships of cadimane-type sesquiterpene derivatives against wood-decay fungi. *Holzforshung* 59: 620-627.

Xu, G., Wang, L., Liu, J. and Wu, J. 2013. FTIR and XPS analysis of the changes in bamboo chemical structure decayed by white-rot and brown-rot fungi. *Applied Surface Science* 280: 799–805.

Yamagishi, Y. and Oye, R. 1981. Influence of recycling on wood pulp fibres-changes in properties of wood pulp fibers with recycling. *Japan Tappi Journal* 35(9): 787-97.

Yang, J.S., Ni, J.R., Yuan, H.L. and Wang, E. 2007. Biodegradation of three different wood chips by *Pseudomonas spp.* PKE117. *International Biodeterioration and Biodegradation* 60: 90-95.

Zeng, J., Singh, D. and Chen, S. 2011. Biological pretreatment of wheat straw by *Phanerochaete chrysosporium* supplemented with inorganic salts *Bioresource Technology* 102(3): 3206–3214.

Zhang, X., Yu, H., Huang, H. and Liu, Y. 2007. Evaluation of biological pretreatment with white rot fungi for the enzymatic hydrolysis of bamboo culms. *International Biodeterioration and Biodegradation* 60: 159-164.