Utilization of Ligninolityc Enzyme in Biobleaching of Pulp from Empty Fruit Bunches of Oil Palm

Happy Widiastuti, Suharyanto, Siswanto
Indonesian Biotechnology Research Institute for Estate Crops
Jl Taman Kencana No 1 Bogor 16151

Abstract

A study was conducted to assess the possibility of using white rot fungi in bleaching of pulp from empty fruit bunches of oil palm (EFBOP) in laboratory scale. Bleaching of EFBOP-pulp was done by inoculating Omphalina *sp. and* Pleurotus ostreatus or their ligninolityc enzyme *and incubated for 20 days.*

The results showed that the opacity of the paper obtained from EFBOP qualify as newspaper. However the physical properties of paper sheets such as tensile index, water absorption, formation, and the degree of white is not yet qualify as a newspaper based on ISO standards. The use of enzyme (100%) for EFBOP bleaching process produces sheets of paper that was not fullfil standard of newsprint. It seem likely that a combination between chemical and biological processes still to be considered for the manufacturing of paper from EFBOP.

Key words: biobleaching, pulp-EFBOP, paper of newspaper

Introduction

At this time most of the pulp produced using chemicals such as alkali to liberate the cellulose fibers from other components (hemicellulose and lignin) and bleaching such as chlorine to reduce the color because of the remaining lignin. Scarcity of raw materials, chemicals and high energy prices and environmental concerns are increasingly pushing the research to produce high-quality paper that behavior is marketed using biotechnology. In addition to saving energy use, use of enzymes can improve the mechanical properties of paper. The results showed that in the process biopulping for two weeks can reduce electric energy more than 30% and improve the quality of the paper on the safe side for the environment. So it can dikataan use of enzymes in pulp and paper industry is an efficient technology and environmentally friendly.

JPP some species produce enzymes that break down lignin. Lignin is a compound found in the middle lamela combined with cellulose and hemicellulose in the wall of the second layer. With the degradation of lignin, the cellulose which is a carbon compound that is needed in the manufacture of paper can increase its concentration. Nevertheless there are problems using JPP as a producer of enzymes ligninolitik ie one organism can produce a mixture of enzymes and vary widely between organsime with one another. However,

theoretically it is possible to use enzymes from the JPP as a biocatalyst in the two processes of pulping and bleaching in paper industry.

Empty fruit bunches of oil palm is the biggest waste generated in oil palm cultivation. Several alternatives have been offered in the utilization of this waste even so the diversity of utilization of this waste will provide stability in oil palm cultivation as a whole. However, paper pulp can be produced from a variety of plant material that has a material or wood fiber. Research the manufacture of paper pulp has been done Goenadi TKKS et al., 1994; Yufnal et al., 1997. Although such research has been done using low-level white mushrooms pelapuk and delignification processes performed by different stages. The experiments were conducted to test the use of enzymes in crude lignolitik biopulping and biobleaching TKKS. As the control is the treatment of pulping and bleaching using chemicals ..

Materials and Methods

TKKS derived from palm oil mills Kertajaya PTPN VII. Sp Omphalina pure culture, and P. ostreatus is a collection BPBPI. At this early stage do Omphalina sp rejuvenation pure culture, for the manufacture of inoculum is then performed. Preparation of inoculum carried out by growing cultures in Petri dishes JPP. As many as a quarter petri inoculum (7 g) was then inoculated into 250 ml of PDB that has added some 0.5% yeast extract were incubated in the dark to enhance the growth of JPP (Palmieri et al., 1997). Manufacture of pulp from TKKS done by sterilizing TKKS, which has diserpih beforehand using an autoclave (1.2 atm, 1 hour). Two types of pulp made is derived from TKKS who has dibiopulping with Omphalina sp (Bp) and which are not in biopulping (control). In this phase some 6 kg of wet TKKS (Ka 70%) inoculated and not inoculated Omphalina sp. TKKS pulping is done by menginokulasi Omphalina sp of 2.5 l culture and incubated for 20 days.

Next TKKS processed for the manufacture of pulp. In the not inoculated Omphalina TKKS sp (control) pulping is carried out by standard procedures using 14% NaOH while Omphalina sp inoculated using 10% NaOH. Some stages are performed in the manufacture of pulp is cooking, washing, drying and milling as well.

The next activity is to test the effectiveness of the enzyme lignolitik JPP on TKKS pulp bleaching process. In this activity carried out in advance the provision of enzymes ligninolitik P. ostreatus grown on medium TKKS. To provide an appropriate amount of enzyme to the bleaching process is done first with the creation of inoculum of P. menginokulasi ostreatus sp 2. on a Petri dish. Next inoculum contained in Petri in inokulasikan on sorghum. Inoculum that grow well, then inoculated into sterile TKKS which

has been put in a plastic bag (bag log) capacity of 100 g dry TKKS that has been enriched with 150 um coper sulfate and 0.075% vitamin B number to optimize production of enzymes and enzyme activity ligninolitik (Palmieri, 1997). Inoculum are given a number of 250 ml per bag log. Harvesting is done after 20 days incubation. Extraction of enzymes performed using phosphate buffer in accordance with optimum conditions. The enzyme obtained selanjutya applied to the pulp. Prior to the application of enzymes in pulp enzyme activity analysis. Furthermore, an enzyme produced from TKKS add as many as 900 ml in 360 grams of pulp into dry sterile TKKS. Incubation is carried out in a plastic bag. Moreover, it also tested the ability of culture and P. sp Omphalina ostreatus in the pulp bleaching process TKKS directly. Bleaching performed using enzymes and cultures for 4 weeks. Both the pulp is treated with enzymes or directly inoculated made sheets of paper and paper quality analysis is then performed.

At a later stage also tested the ability of the enzyme ligninolitik pulping (100%) which is extracted from TKKS. At this stage the enzyme preparation is done by preparing inoculum of P. ostreatus first. In the next phase is already available inoculum was inoculated in sterile TKKS already diserpih and cut. After incubated for 2 weeks then performed ligninolitik enzyme extraction. Ligninolitik enzyme obtained is used for pulping TKKS who was ready. Two ways a TKKS as pulp material is carried out by (L1) or without giving lipase (L0). After incubation for 2 weeks then made a sheet of paper.

Results and Discussion

In this study JPP biobleaching done either by directly or indirectly through an enzyme that is produced by JPP ligninolitik grown in TKKS. The results showed that the opacity of paper sheets obtained from the use of enzymes and cultures biobleaching qualify as newsprint. Based on ISO 14.0091.1998 opacity newsprint is above 90%. Treatment with cultured P. ostreatus produces the highest opacity (Table 1). Tensile properties of the index increased compared with controls. Treatment achieved the highest increase in the use of culture Omphalina sp. Nevertheless tensile index is still not qualify as newsprint (SNI 22.45 - 50nm / g). Absorption is very high on the use of enzymes but with the use of culture water absorption lower than in controls. Achieved the lowest water absorption on the use of culture Omphalina sp.

Table 1. Properties of paper sheets from the treatment without biopulping TKKS but with biobleaching.

Parameter	Units	Control	Bb (E JTT)	Bb (K A1)	Bb (K JTT)
Opacity	%	99,0	99,3	99,3	**99,4**
Indeks tarik	Nm/g	4,13	6,17	7,2	**11,9**
Daya serap air	g/m2	105,7	193,2	**77,9**	84,5
Formasi	NUI	58,4	43,6	16,9	13
Derajat putih		25,31	**26,85**	25,54	25,18

ote: Bb (E JTT): biobleaching using enzymes from P. ostreatus
Bb (K A1): biobleaching using culture Omphalina sp
Bb (K JTT): biobleaching using cultures of P. ostreatus

Nevertheless water absorption is still not eligible SNI (less than 20 g/m2). Other characteristics of the formation (uniformity of sheets of paper) not yet qualify as a sheet of newsprint. Similarly, the characteristics of degrees of white are not yet qualified as newsprint (SNI 55%). Nevertheless the enzyme treatment gives the highest degree of white compared with other treatments.

Properties of paper sheets on treatment with biopulping TKKS and biobleaching presented in Table 2. In the table shown that the opacity of the sheet of paper from TKKS qualify as newsprint. Tensile index increased by administering biobleching enzyme as compared with controls. Nevertheless this character is not yet qualify as a newspaper based on SNI. Absorption is still too high compared to the ISO standard. Similarly, character formation. Slightly increased the degree of white characters on enzyme treatment compared with controls.

Table 2. Properties of paper sheets on treatment with Biopulping TKKS

Parameter	Units	Bp	Bp + Bb (EJTT)	Bp + Bb (KA1)	Bp + Bb (KJTT)
Opacity	%	**99,5**	**99,4**	**99,2**	**99,0**
Indeks tarik	Nm/g	8, 06	**8,35**	6,42	7,33
Daya Serap Air	g/m2	**71,1**	85,6	144,2	80,2
Formation	NUI	17,4	15	20,5	18,9
Derajat putih		23,54	**23,86**	22,25	22,68

Note:
Bp: biopulping use
Bb (E JTT): biobleaching using enzymes from P. ostreatus
Bb (K A1): biobleaching using culture Omphalina sp
Bb (K JTT): biobleaching using cultures of P. ostreatus

Enzymes that play a role in bleaching is MNP while working on a compound substrate lac nonfenolik. In addition to MNP also play a role in bleaching can lower kappa number. MNP works in depolimerisasi lignin by oxidizing MnII be MnIII form simple phenolic compounds. The results showed that the addition of 0.2 mN MnSO4 enough to process biobleaching using MNP. MNP is an essential enzyme for biobleaching hard wood by P. chrysosporium. The ability of the enzyme from P. MNP ostreatus seems still needs to be improved so that more optimum in the bleaching process. Nevertheless the enzyme laccase can also be used for pulp bleaching process which is made from sulfite process. In this study the pulping process is not through sulfitasi but through the provision of soda. The difference this process which may lead to less effective laccase enzyme activity. In addition, the results showed that biopulping Phanerochaeta chrysosporium is at 390C while Cerisporium subvermispora Lip 27-320C. In this study the possibility needs to be re-defined the optimum temperature for enzyme activity in addition to other conditions such as pH and moisture so that the enzyme activity in a more optimum biobleaching process.

Experiments to do biopupling using enzymes alone (100% biopulping) produces sheets of paper that still needs to be upgraded (Figure 1). treatment combinations

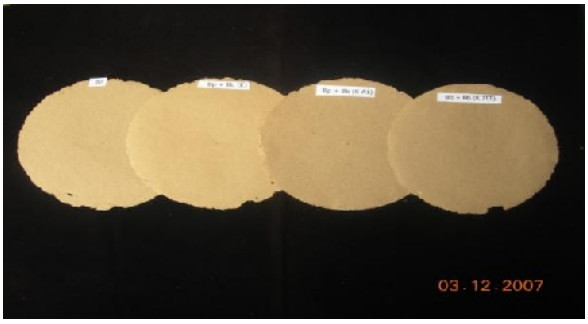

Figure 1. Sheet of paper and biobleaching biopulping TKKS through (semi-chemical, 30%). Control, and biobleacing enzyme biopulping P. ostreatus, P. biopulping and culture biobleaching ostreatus, and P. biopulping and culture biobleaching ostreatus. (from left to right)

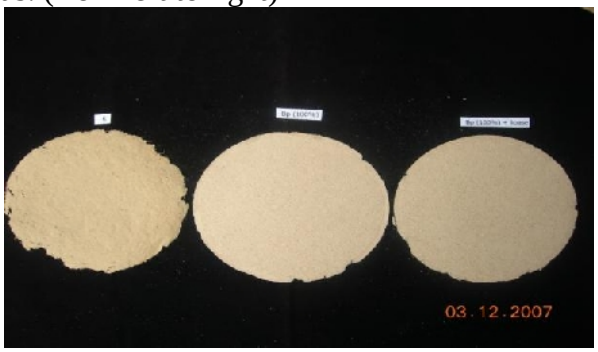

Figure 2. Sheets of paper from TKKS biopulping results using the enzyme 100%. Control (left), without lipase (middle), and with lipase (right).
chemistry and biology seem to produce sheets of paper from TKKS better.

Conclusions and Suggestions

Improved physical properties of paper sheets can be done with the treatment TKKS biobleaching and accompanied biopulping biobleaching. Characteristics of the sheet of paper only and biopulping accompanied biobleaching biobleaching using enzymes and cultures JPP produce sheets of paper that meets the requirements particular to the nature of opacity. Optimization of temperature, humidity, and pH should be determined to obtain the optimum pulping and bleaching. Combination of chemical and biological treatment seems to be considered to produce a sheet of paper from TKKS with better quality.

References

Artiningsih, T. Application of microbial enzymes for pulp and paper industry. Makalah dalam seminar Permi cab Bogor

Palmieri, G. P Giardina, C. Bianco, A. Sealoni, A. Capasso, G. Sannia. 1997. A novel white laccase from *Pleurotus ostreatus*. 272(50): 31301-31307.

Pasaribu, RA., S.B. Lestari. 2003. Efektivitas fungi Cipanas dalam biokonversi tandan kosong kelapa sawit (TKKS) menjadi pulp kertas koran. Buletin penelitian hasil hutan. 21(3): 189-202

Suprapti, S. 1988. Budidaya jamur perusak kayu I. Pengaruh penambahan dedak terhadap produksi jamur tiram. Jurnal Penelitian Hasil Hutan. 5(6): 337-339.