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Reliability Analysis of Oil Palm Empty Fruit Bunch Fibers by using Weibull Distribution

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Abstract – *The reliability of the oil palm empty fruit bunch fiber (OPEFB) is based on reddish pulp which is obtained from fruit of oil palm tree, is processed to yield edible vegetable oil. The OPEFB fibers were prepared by milling of fibers and sieving of fiber to obtain various size of fiber such as long, medium, short and micro particle. The purpose of this paper is to check the reliability of the reddish pulp by using Weibull Distribution which can be used to determine the probability of Size of fiber for long, medium, short and micro. These four parameter Weibull Distribution has a symmetric pattern on density function of the data and the analysis describes the reliability of OPEFB.*

KeyWords: *oil palm empty fruit bunch fiber, Reliability, Weibull distribution, etc*

1. INTRODUCTION

India is the world largest oil palm (Elaeis guineensis) importer of oil palm empty fruit bunch fiber. In India, oil palm is being cultivated in 13 states by covering about 3,50,000 hectares by 2018-19 under irrigated conditions. Potential states are Andhra Pradesh, Gujarat, Karnataka, Tamil Nadu and Bihar. Which registered palm oil as the largest oil production over rapeseed oil. However, disposal oil palm biomass is the great concern issue in oil palm industry. The oil palm industry contributes enormous amount of the biomass as oil palm empty fruit bunch fiber. In this study we perform pre-treatment of biomass like acid alkali treatment, steam explosion, ammonia fiber expainson after that hydrolysis treatment has been performed which will converted in to hexoses and pentoses and process it to fragmentation crushing. This biomass can be used to produce organic fertilizer. However there are cases where this biomass is burned uncontrollably near the processing line with a negative impact on the local as well as the global environment. Reliability analysis is very useful in the oil palm empty bunch fiber it is a great challenges in order to analyse its reliability by using weibull distribution. It was perform to make a clear difference among all of the treatments. Because of the abundant of the oil palm empty fruit bunch fiber.

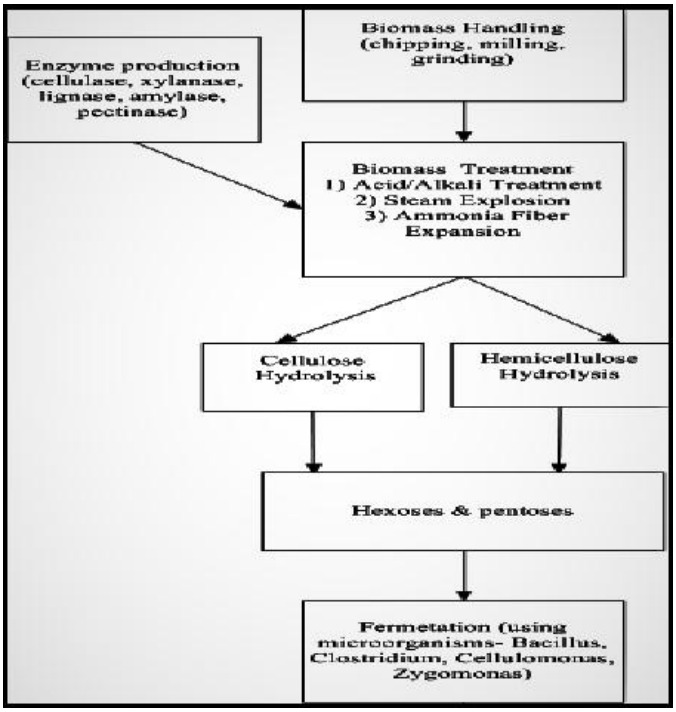

Fig.1 Flow chart of pre-treatment of biomass

2. METHOD

2.1 MATERIALS

The waste was collected from different places, namely: OPEFB was obtained from Gujrat. The waste material was cleaned and selected; then, pre-treatment process was conducted before the mixing process to remove lignin, cellulose, and another compound which prevents the stickiness and hardening. The EFB fiber of oil palm were processed by chemical-mechanical process with precaution to reduce severe damages of fibers under the following procedures:

a)Preparation of sample for reliability analysis

b)Conversion of the softened sample into fiber by mechanical action

c)Washing, Screening and drying of resulting fiber

2.2 PRETRATMENT OF BIOMASS

Table -1: Pretreatment of biomass

Pretreatment of biomass			
Method	**Condition**	**Performance lignin removed (%)**	**References**
Pre-treatment physicochemical With NaOH	Drying, grinding and shaking after alkaline hydrotreatment First heated to 180 ºC. Cooled 40 ºC. Mass of biomass 30g. Volume of water 300 mL. Reaction time 10 min. 1.2 g of NaOH.	NaOH addition (90.08 %)	[1]
Sequential acid/alkali treatment with H2SO4 and NaOH	Heated at 105-121ºC and 15 psi for 24 hrs. 4% (v/v) H2SO4 solution and 10 N NaOH solutions.	The delignification yield was 70%.	[2]
Phosphoric acid pretreatment and combined with fungi.	fungus Pleurotusflorida nus to 31 ºC and neutral PH, 8 ml phosphoric acid (85.7%), Washed with 40 mL acetone and centrifuged at 1900g	Phosphoric acid pretreatment 89.4% and combined with lignin yield of 62.8%.	[3]
Chemical pretreated with aqueous ammonia	60 C, 12 h, and 21% (w/w) aqueous ammonia	41.1% lignin removal	[4]
Acid pretreatment with sulfuric acid	1% (w/v) sulfuric acid, to 190 C and dried at 45 C for more than 3 days	decreasing 90% the lignite content in sample	[5]
Alkaline hydrotreatment with NaOH	95 g NaOH (8% p/v), for heated at 100 º C for 10, 20 and 60 min, dried at 10000 rpm	conversions of lignin solids of 96%	[6]
Physical and hydrotreatment simultaneously with NaOH and CaOH with H2O2	Dry at 105 C for 24 hrs. to 5 gr sample, concentrations 100 mMNaOH and CaOH with H2O2 and dried 100 ºC	Almost 100% of lignin	[7]
Phisycal and Chemical treatment with NaOH and irradiation	Dried and milled NaOH 10%, 150 ºC, ratio 5:1 NAOH and EFB and irradiation 8 (energy variation of 100 kGy up to 500 kGy)	92,2% total lignin removed	[8]
Pretreatment dilute acid (H2SO4)	Optimal condition 161.5 C, 9.44 min and 1.51% acid loading	Content of lignin removed of sample to 43% lignin yield	[9]
Steam explosion (SE) pretreatment	300 gr of OPEFB was dried at 65 ºC for 72 h. saturated with steam to 195 ºC for 6 min	Lignin analyses showed a reduction of 68.12%	[10]
Physical and alkaline treatment combined with NaOH	Dried at 65 ◦C for 48 h, milled, sieved through a mesh 42 (0.350 mm) NaOH of 0,5 to 5,5% in solution at 121 ºC and 80 min	Presence of lignin decayed in a 70%	[11]
Chemical pretreatment with NaOH and mechanical pretreatment	3% NaOH, 110 C for 45 min. milled to average 1mm and washed with water	85% lignin removal	[12]
Physical and chemical pretreatment	Washed, defibrated and ground. AFEX at 135 °C, 45 min retention time.	Particle size was reduced	[13]
Chemical pretreatment with NaOH	NaOH 127.64 ◦C, 22.08 min, and 2.89 mol L−1	74,33% lignin removal	[14]
Physical and acid pretreatment	Dried and milled. The sulfuric acid at 100 ◦C to 150 ◦C, time ranged	63% total lignin removed	[15]

	from 30 to 90 min, and acid loading 0 to 1.3% weight acid/weight liquid.		
Chemical pretreatment with Ethanol/benzene, NaClO2, KOH and deionized water	The EFB of 0,5 - 1cm. Ethanol/benzene (1:2 v/v) mixed solvent. NaClO2 solution at (pH 4–5) at 70 C for 1 h. 6 wt% KOH solution at 20 ºC for 24 h. deionized water until the pH 7	Average thickness of nanofibers was within the range 1– 3.5 nm	[16]
Biological pretreatment	Six days at 30º C cultivated. P. ostreatus CECT 20311 fungi	The lignin degradation to 50% with P. ostreatus, a higher value than the 41% reached with P. chrysosporium	[17]
Chemical pretreatment (Ozone treated) with NaOH	For ozonetreated:100 mL of NaOH (5 wt.%) for 1 h. washed with distilled water. dried in the oven at 105 °C for 50 min	lignin degradation of 84.7 wt.%	[18]
Bisulfite pretreatment	Pretreated samples were washed and Five oxygen-catalyzed at 0.6 MPa and 30 min at 120 ºC	Lignin removed 75%	[19]
Phisycal and Bisulfite pretreatment	Milled to particle sizes ranging from 0.30 to 0.45 mm. Pretreated samples were washed and Five oxygencatalyzed at 0.6 MPa and 30 min at 120 °C	Lignin removed 79,6%	[20]
Bisulfite pretreatment	t The bisulfite pretreatment at (180 C, 30 min, 8% NaHSO3, 1% H2SO4). Reacted with a solution of sodium bisulfite at 180 C for 30 min, at 8% and 10% NaHSO3	Lignin removed 79,1%	[21]
Phisycal pretreatment (Ball milling (BM))	6–24 h, constant speed of 230 rpm	Lignin removed 81,32%	[22]
Phisycal, chemical and hydrothermal treatment, combined.	Crushed particle size 5 mm. 1% NaOH (w/w). team treated at 230 C for 15 min in pressure vessel	Lignin decrease until 80 %	[23]
High-pressure steam pre-treatment (HPST)	Press-shredded at 250 ºC and 9.4 MPa. HPST conditions of 170/0.82, 190/1.32, 210/2.03, and 230 ºC/3.00 MPa for 2, 4, 8, and 10 min. oven-dried at 105 ºC for 24 h	Lignin reduction of 83%.	[24]
Chemical pretreatment (organosolv pretreatment)	Aqueous ethanol 1:10 (10 g in 100 mL). Concentration (35, 55, and 75% vol), at reaction temperature (80, 100, and 120 °C) and reaction time (30, 60, and 90 min). (KMnO4) 0.1 N, Sulfuric acid (H2SO4) 4.0 N and Potassium iodide (KI) for 10 minutes	Decrease lignin concentration of 75%	[25]
Alkaline pretreatment with NaOH and steam.	Wash EFB with NaOH 2%, 4 h at 30 ºC, with solid to liquid ratio of 1:10. Heating at 121 C and 117	Lignin removed 92.3 %.	[26]

	kPa during 6 min		
Chemical pretreatment with sulfuric acid	Air-dried and pretreated at 170 C with 0.8 wt% sulfuric acid and a solid/liquid ratio of 1:6. stirring speed 100 rpm and 15 min	lignin content decreased	[27]
Ultrasonic pretreatment with H2SO4	500 ml of 2% H2SO4 with 50 g of OPEFB. Ultrasonicated at a power of 2 kW, 20 kHz for 15, 60 and 45 min, and amplitude of study was 15%, 60% and 90%	Lignin removed 81,9 %.	[28]
Alkaline pretreatments	Washed, air-dried and refined to size of about 2-4 cm. applied pre-treatments at liquid/solid ratio 12:1 for 60 min, Sodium Hydroxide (NaOH) 2% w/v, 120 ºC. The fibers were washed and spin-dried	Lignin removed 91,3 %.	[29]
Sequential pretreatment (Phisycal, dilute acid and alkali pretreatment)	Washed and dried at 90 C for 24 h. Dilute sulfuric acid at concentration of 0,1-8,0% (v/v) at 121 C, 15 psi for 1 h, 10 N NaOH solution at ambient temperature for 4 h, then, was heated at 121 C, 15 psi for 15 min	Removed 70% lignin.	[30]

3. RELIABILITY ANALYSIS USNING THE WEIBULL DISTRIBUTION

The variability of the fracture strength of OPEFB fibres suggests that it may be modelled in a statistical sense to help us address the overall reliability of the fibres for reinforcing composites. To order of magnitude, estimate of the statistical variation of strength of the fibres may be described using a Weibull distribution (Weibull 1951; Moser et al. 2003), assuming that the fracture strength is notappreciably dependent on the rate of loading. According to the Weibull formulation, the cumulative failure probability, Pr, of a population of the OPEFB fibres isrelated to the stress, σ, applied as

$$Pr(\sigma)=1-\exp(-[\sigma/\sigma o]\ \beta \qquad \text{.....(1)}$$

where β and σ0 are the Weibull modulus and the characteristic strength, respectively. The cumulative failure probability of a population of fibres of number N0 where N0 is large could be thought of as the number of fibres (N0 – N) having abreaking strength less than or equal to σ/ N0, so

$$Pr(\sigma) \approx No\text{-}N/No= 1\text{-}N/No \qquad \text{.....(2)}$$

Consider a bundle containing initially N0 fibres, all of the same length, loaded only from the ends of the fibres. The fibres possess identical load-elongation behaviour (differing only in the strengths as well as elongations to break of the respective fibres), then the load F borne by the bundle is given by

$$F= \sigma AN \qquad \text{.....(3)}$$

where N is the number of unbroken fibres all of cross-sectional area A and all bearing the same stress σ. If a fibre breaks, it no longer bears any load, so Eqs. (1), (2) and (3) then say that the number of fibres surviving application of the F to the bundle satisfies

$$N/No=\exp(-[F/\ No\ \sigma o'A]\ \beta\ \{No/N\}\ \beta) \qquad \text{.....(4)}$$

where: σo'stands for σo /L1/β (which is the statistical mode of the strength distribution for fibres of small dispersion in strength). The maximum load which can besustained by a bundle is obtained from Eq. (3), as the maximum value of the product σN, and since N = No (1 – Pr(σ)) for any distribution, Weibull or not, the maximum load is determined by the maximum value of the quantity σ[1 – Pr(σ)]. For the Weibull distribution, this is obtained by differentiating Eq. (4) and equating to zero to obtain

$$Fbun = No\ \sigma o'Ae\text{-}1/\ \beta\ \beta\text{-}1/\ \beta \qquad \text{.....(5)}$$

The 'ultimate tensile strength' of the bundle, σbun, i.e. the maximum load divided by the initial area of cross section, is then Fbun/(No A), i.e.

$$\sigma bun= Fbun/\{NoA\}= \sigma o'Ae\text{-}1/\ \beta\ \beta\text{-}1/\ \beta \qquad \text{.....(6)}$$

The stress in the remaining fibres (not broken) is σ'0/β1/β and there are No /exp (1/β) of these. Thus the load, F/{ No σo'A}, supported by the bundle increases linearly with increase in stress on a fibre, σ/ σo', for a given m. Beyond a critical σ/ σo', increasing σ/ σo'leads to a less rapid, but non-linear, increase in F/{ No σo'A } (= {σ/ σo'}exp(−[σ/ σo']β));

a peak value is reached beyond which the F/{ No σo'A} decreases with increase in σ/ σo'..

4. CONCLUSIONS

According to the reliability analysis result of oil palm empty fruit bunch fiber with the four parameter weibull distribution conclude that:

1. The four parameter weibull distribution can be used to determine the reliability of OPEFB.
2. The four parameter weibull distribution has a symmetric pattern on density function of data.
3. High potential of reliability analysis of OPEFB.
4. At medium size of fiber occurs higher reliability.

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BIOGRAPHIES

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