Researchers at USA have previously reported that pearl millet (PM) could substitute corn and reduce the amount of flaxseed (8%, FS) needed to produce omega-3 enriched eggs in a 6 week trial, but reduced yolk pigmentation. In this study they evaluated egg fatty acid (FA) profile, yolk pigmentation, laying performance and liver integrity in a 12 week experiment using PM-based diets with lower levels of FS (4, 6 and 8%) and natural pigments (PG, 0.1 and 0.2%) in a factorial arrangement of treatments (six cage replicates per treatment). Diets were formulated to be isocaloric and isonitrogenous and to meet or exceed NRC requirements. Egg number and egg mass produced were measured and recorded on a daily basis, whereas BW and feed consumption measurements were recorded every two weeks. At the end of each two week period, three eggs were collected from each cage to measure egg trait parameters and then yolks were separated, pooled and lyophilized for FA determination by Gas Chromatography. At the end of the experiment, all the hens were euthanized to determine liver integrity. Egg traits and flock performance parameters, were not different among treatments, except in week 8, 10 and 12, when birds fed PM-based diets including 8% FS produced smaller ($P < 0.05$) eggs than hens fed 4% FS. The inclusion of the PG at 0.1% restored yolk pigmentation to marketable levels (above 7 on the Roche® color fan scale). In summary, birds fed a diet containing PM as the sole grain source and 6% FS, consistently produced eggs with more than 350 mg/egg of n-3 FA, which is the lower standard to market eggs as “omega-3 enriched”, whereas hens fed the diet containing 8% FS produced eggs with about 500 mg/kg of n-3 FA. Liver integrity was not affected by dietary treatment. Thus, PM based diets with levels as low as 6% of FS and low levels of natural PG (0.1%) can be used to produce n-3 FA enriched eggs, preserving egg quality and restoring yolk colour, and maintaining hen health and productive performance [Amini Ki and Ruiz-Feria CA, Production of Omega-3 fatty acid enriched eggs using pearl millet grain, low levels of Flaxseed and natural pigments, Int J Poultry Sci, 2008, 7(8), 765-772].

The scientists at Engineering College of Lorena, Brazil and Faculty of Chemical Engineering, Colombia reported the effect of fungal pretreatment of sugarcane straw in the performance of the treated pulps. Fermentation time, fungal mycelium load and pretreatment scale were studied in the fungal treatment, and the best conditions were 15 days with 250mg/kg fungal mycelium per straw weight causing high lignin decomposition. At the largest scale tested (50g straw) lignin degradation exceeded cellulose degradation by 2.4-fold. Acetosolv pulping was carried out in a tank reactor at 120°C. The pulping kinetics showed that for biopolps the final lignin content was around 7.5% with a reduction of 40% in the pulping time to reach 12.5% pulp lignin, besides the factorial design showed that the biological pretreatment had a positive effect on the acetic acid reduction (21.5wt%) during pulping process [Saad MBW, Oliveira LRM, Cândido RG, Quintana G, Rocha GJM and Gonçalves AR, Preliminary studies on fungal treatment of sugarcane straw for organosolv pulping, Enzyme Microb Technol, 2008, 43(2), 220-225].
Xylanase recycling for the economical biobleaching of sugarcane bagasse and straw pulps

The scientists at Brazil evaluated the applicability of xylanases in sugarcane straw pulps and the possibility of recovering this enzyme. A commercial xylanase (Pulpzyme HC) was used for pulp treatment and this enzyme was recovered and reused several times in the new pulp enzymatic treatment without addition of new enzyme load. In addition, a combined process of pulping was also evaluated, such as the fungal pretreatment of straw (biopulping) and the acetosolv pulping. Quantity of recovered enzyme in the first treatment was approximately 7% of initial enzyme load. After the second treatment no enzyme recovery was possible. Several factors interfered on xylanase recovery, such as pulp type, treatment medium (buffered or aqueous) and the methodology employed in the enzyme recovery. An alkaline extraction stage was carried out to verify the action of Pulpzyme on enzymatic treated pulps, but due to concentration of NaOH used in the stage differences were not observed in the kappa numbers and viscosity of the pulps. The Fourier transform infrared and principal component analyses (FTIR–PCA) were used to analyze sugarcane bagasse pulps of a previous work and FTIR–PCA showed differences among untreated, xylanase-treated and alkaline-extracted pulps of sugarcane bagasse [Gonçalves AR, Moriya RY, Oliveira LRM and Saad MBW, Xylanase recycling for the economical biobleaching of sugarcane bagasse and straw pulps, Enzyme Microb Technol, 2008, 43(2), 157-163].

Enzyme-based control of oxalic acid in the pulp and paper industry

Enzymatically catalyzed decomposition of oxalic acid in bleaching filtrates from the pulp and paper industry offers a possibility to enduringly prevent oxalate scaling problems by specific removal of the oxalic acid in the system rather than by attempting to avoid calcium oxalate precipitation by countermeasures aiming at improved solubility. To achieve a broad evaluation of various oxalate-degrading enzymes and to cover conditions encountered in various types of processes, the scientists at Sweden collected 16 different bleaching filtrates from pulp mills engaged in mechanical pulping of softwood, mechanical pulping of aspen and kraft pulping of softwood. A novel oxalate-degrading enzyme provided by Novozymes was compared with commercially available oxalate oxidase from barley and oxalate decarboxylase from Aspergillus niger. The activity of the enzymes in the filtrates was investigated using kinetic analysis and multivariate data analysis. Kinetic analysis indicated that the degradation rates were governed more by inhibitors in the filtrates than by the concentration of oxalic acid. Multivariate data analysis suggested links between high concentrations of certain compounds in the filtrates and high or low enzyme activity, as exemplified by the link between high concentrations of chelators in filtrates from mechanical pulping and low activity of oxalate oxidase from barley. All three enzymes could degrade oxalic acid in all filtrates, despite the fact that very high concentrations of residual hydrogen peroxide were found in several of the filtrates [Sjöde Anders, Winestrand Sandra, Nilvebrant Nils-Olof and Jönsson Leif J, Enzyme-based control of oxalic acid in the pulp and paper industry, Enzyme Microb Technol, 2008, 43(2), 78-83].

Kinetic modeling of formic acid pulping of bagasse

Organic solvent or organosolv pulping processes are alternatives to soda or kraft pulping to delignify lignocellulosic materials for the production of paper pulp. The scientists at University of Technology, Guangzhou, China examined formic acid, a typical organosolv system, has been presently examined under atmospheric pressure to pulp bagasse fibres. It was shown that efficient bagasse pulping was achieved when the formic acid concentration was
limited to 90% (v/v). A statistical kinetic model based on the experimental results for the delignification of bagasse during formic acid pulping was developed that can be described as follows:

\[ D(\text{delignification}) = 0.747 \times C(\text{formic acid})^{1.688} \times (1-e^{-0.05171t}) \]

an equation that can be used to predict the lignin content in formic acid during the pulping process. The delignification of bagasse by 90% formic acid was almost completed after approximately 80 min, while extended pulping did not improve the delignification but tended to degrade the carbohydrates in bagasse, especially the hemicelluloses, which were rapidly hydrolyzed at the onset of pulping [Tu Q, Fu S, Zhan H, Chai X, Lucia LA, Kinetic modeling of formic acid pulping of bagasse, *J Agric Food Chem*, 2008, 56(9), 3097-3101].

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**Neural fuzzy model applied to ethylene-glycol pulping of non-wood raw materials**

The scientists at Spain studied the influence of the operational variables (viz. ethylene-glycol concentrations of 50-70%, temperatures of 155-185°C, times of 30-90 min and numbers of PFI beating revolutions of 500-1500) on pulp yield and various paper properties (breaking length, stretch, burst index, tear index and brightness) obtained in the ethylene-glycol pulping of vine shoots, cotton stalks, leucaena [*Leucaena leucocephala* (Lam.) de Wit] and tagasaste [*Chamaecytisus proliferus* (Linn. f.) Link]. The fuzzy neural network models used reproduced the experimental results with errors less than 15% and smaller than those provided by second-order polynomial models in all cases.

An ethylene-glycol concentration of 65% at 180°C for 75 min and 1500 PFI beating revolutions were found to provide substantial savings in energy, chemicals and facility investments as a result of operating under milder conditions than the strongest ones studied in this work. Tagasaste was found to be the most suitable raw material among those tested as it provided the paper sheets with the highest breaking length (4644 m), stretch (2.87%), burst index (2.46 kN/g), tear index (0.33 m Nm²/g) and brightness (40.92%); its pulp yield was also high (62.88%), which reflects efficient use of this raw material [Rodríguez Alejandro, Pérez Antonio, de la Torre María Jesús, Ramos Enrique and Jiménez Luis, Neural fuzzy model applied to ethylene-glycol pulping of non-wood raw materials, *Bioresour Technol*, 2008, 99(5), 965-974].

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**Use of high-boiling point organic solvents for pulping oil palm empty fruit bunches**

Oil palm empty fruit bunches were used as an alternative raw material to obtain cellulosic pulp. Pulping was done by using high-boiling point organic solvents of decreased polluting power relative to classical (Kraft, sulphite) solvents but allowing operation at similar pressure levels. The holocellulose, α-cellulose and lignin contents of oil palm empty fruit bunches (viz. 66.97, 47.91 and 24.45%, respectively) are similar to those of some woody raw materials such as pine and eucalyptus and various non-wood materials including olive tree prunings, wheat straw and sunflower stalks.

Pulping tests were conducted by researchers at Spain using ethyleneglycol, diethyleneglycol, ethanolamine and diethanolamine under two different sets of operating conditions, namely: (a) a 70% solvent concentration, 170°C and 90 min; and (b) 80% solvent, 180°C and 150 min. The solid/liquid ratio was six in both cases. The amine solvents were found to provide pulp with better properties than did the glycol solvents. Ethanolamine pulp exhibited the best viscosity and drainage index (viz. 636 ml/g and 17 SR, respectively), and paper made from it the best breaking length (1709 m), stretch (1.95%), burst index (0.98 kN/g) and tear index (0.33 mNm²/g). Operating costs can be reduced by using milder conditions, which provide similar results. In any case, the amines are to be preferred to the glycols as solvents for this purpose [Rodríguez Alejandro, Serrano Luis, Moral Ana, Pérez Antonio and Jiménez Luis, Use of high-boiling point organic solvents for pulping oil palm empty fruit bunches, *Bioresour Technol*, 2008, 99(6), 1743-1749].
Delignification of *Eucalyptus globulus* Labill. saplings in two organosolv systems

Organosolv methods are recognized as viable sulphur-free alternatives to traditional pulping techniques. Researchers at Spain investigated the pulping of 2-3 years old *Eucalyptus globulus* Labill. saplings by formic and acetic acid-based organosolv methods fitting the results with empirical models for prediction of pulp yields and kappa numbers from process variables. Additionally a preliminary study on the recuperation of lignin dissolved and its functionalities has been performed. Organosolv delignification of 2-3 years old *E. globulus* with formic or acetic acid produced bleachable grade pulps with kappa number values of 20-35. Pulp yields for the acetic acid treatment (45-55%) were higher than for formic acid (32-46%) although they also showed the greater kappa number. Delignification was modelized by means of the accomplishment of respective factorial designs of experiments. Recuperation of the dissolved lignin, by means of water precipitation, allowed the recovery of about a 20% of the initial raw material (about 80% of lignin). The chemical characteristics of the recovered lignins suggest that they are sufficiently reactive to be usable as phenol-lignin-formaldehyde resins [Ligero Pablo, Villaverde Juan José, de Vega Alberto and Bao Manuel, Delignification of *Eucalyptus globulus* saplings in two organosolv systems (formic and acetic acid): Preliminary analysis of dissolved lignins, *Ind Crops Prod*, 2008, 27(1), 110-117].

**Hibiscus cannabinus** Linn. and **Hibiscus sabdariffa** Linn. as an alternative pulp blend for softwood

Due to dearth of forest based raw materials paper technocrats have explored the possibility of alternate cellulosic fibrous raw materials. *Hibiscus cannabinus* Linn. (Kenaf) and *H. sabdariffa* Linn. (Red Sorrel)— agro-based residues bear the characteristics of both, the softwood and hardwood fibres. The bast fibres of them resemble with softwood and core fibres with hardwood. Morphological analysis and chemical composition of both show their suitability for producing paper of various grades. The study carried out by researchers of India provides optimized soda pulping conditions for better utilization of both species. Due to identical pulping conditions both species can be delignified together. The optimum cooking conditions were found to be as, active alkali 18% (as NaOH), temperature 165°C, time (at temperature) 180 min and wood to liquor ratio of 1:4.5. An AQ dose of 0.05% at an active alkali dose of 13% (as Na₂O) produces the screening rejects and kappa number similar to that obtained by using 15% active alkali (as Na₂O) [Upadhyaya JS, Dutt Dharm, Singh Bahadur and Tyagi CH, *Hibiscus cannabinus* and *Hibiscus sabdariffa* as an alternative pulp blend for softwood: Optimization of soda pulping process, *Indian J Chem Technol*, 2008, 15(2), 277-286].
Thermal stability and pyrolysis kinetics of organosolv lignins obtained from *Eucalyptus globulus* Labill.

In a study by researchers at Spain thermogravimetric analysis of 17 organosolv lignin samples was carried out to determine their thermal stability and calculate the kinetic parameters of their pyrolysis. The thermal stability has been estimated by the measurement of the degradation temperature (\(T_d\)), calculated according to the maximum reaction rate. In addition, degradation temperature at 10% of conversion (\(T_{10\%}\)) has been obtained in order to compare the initial stability of the samples with \(T_d\) for all samples. The values of \(T_d\) are comprised between 262 and 389°C and the average value is 340°C. The range for \(T_{10\%}\) is 251-320°C and the average value is 270°C. The ashes content of the samples has been analyzed and all the residues presented values lower than 4 wt%. Kinetic parameters of lignin pyrolysis were calculated by Borchardt-Daniels' method assuming \(n\)th order reaction. The activation energy values obtained are comprised between 17.9 and 42.5 kJ/mol and the average value is 28.1 kJ/mol. These results are in agreement with the bibliography. However, it would be useful to extend kinetic methods to more complex ones. This could lead to a determination of the influence of multiple effects, such as the influence of operating conditions of wood cooking and the lignin composition. In addition, the approach could be extended to determine the kinetic parameters of thermal degradation of other natural polymers [Domínguez JC, Oliet M, Alonso MV, Gilarranz MA and Rodríguez F, Thermal stability and pyrolysis kinetics of organosolv lignins obtained from *Eucalyptus globulus*, *Ind Crops Prod*, 2008, 27(2), 150-156].

Bleaching of soda pulp of fibres of *Musa textilis* Nees (Abaca) with peracetic acid

Researchers of Spain studied the influence of operational variables in the bleaching of soda pulp of *Musa textilis* Nees also known as Abaca or Manila Hemp [viz. temperature (55-85°C), bleaching time (30-150 min) and peracetic acid concentration oven dry pulp (0.5-4.5%) on the kappa number and viscosity of the bleached pulp, as well as on the breaking length, burst index and brightness of paper sheets made from it. For this purpose, they used a central composite factorial design in order to identify the optimum operating conditions. In this way equations relating the dependent variables to the operational variables of the bleaching process were derived. These equations reproduce the dependent variables with errors less than 12% for all, except the viscosity which was predicted with errors less than 18%. Obtaining bleached pulp with the highest possible viscosity (1519 ml/g), and paper sheets with the maximum possible breaking length (6547 m) and burst index (5.00 kN/g), entails using a temperature of 55°C, a peracetic acid concentration of 4.5% and a bleaching time of 150 minutes. This provides a brightness of 79.90%, which is only 6.53% lower than the maximum possible value (85.48%) [Jiménez L, Ramos E, De la Torre MJ, Pérez I and Ferrer JL, Bleaching of soda pulp of fibres of *Musa textilis* Nees (abaca) with peracetic acid, *Bioresour Technol*, 2008, 99(5), 1474-1480].