Natural cellulose fibres from Switchgrass with tensile properties similar to cotton and linen

The scientists at University of Nebraska-Lincoln, Lincoln, Nebraska, USA reported the production and characteristics of natural cellulose fibres obtained from the leaves and stems of Switchgrass (***Panicum virgatum* Linn.**). The composition, structure and properties of fibres obtained from the leaves and stem of switchgrass have been evaluated in comparison to the common natural cellulose fibres, such as cotton, linen and kenaf. The leaves and stems of switchgrass have tensile properties intriguingly similar to that of linen and cotton, respectively. Fibres were obtained from the leaves and stems of switchgrass using a simple alkaline extraction and the structure and properties of the fibres were studied. Fibres obtained from switchgrass leaves have crystallinity of 51%, breaking tenacity of 5.5 g per denier (715 MPa) and breaking elongation of 2.2% whereas the corresponding values for fibres obtained from switchgrass stems are 46%, 2.7 g per denier and 6.8%, respectively. Switchgrass is a relatively easy to grow and high yield biomass crop that can be source to partially substitute the natural and synthetic fibres currently in use. Hopefully, this research will stimulate interests in using switchgrass as a novel fibre crop in addition to being promoted as a potential source for biofuels [Narendra Reddy and Yiqi Yang, Natural cellulose Fibres from switchgrass with tensile properties similar to cotton and linen, *Biotechnol Bioeng*, 2007, **97**(5), 1021-1027].

Study of the tensile properties of stinging nettle fibres

Developing new natural fibre composites is the focus of many studies today. Indeed, they are made out of renewable resources and, therefore, have a lower environmental impact in comparison to mineral fibre composites. The scientists at Université de Bretagne Sud, France measured and compared the mechanical performances of stinging nettle fibres (***Urtica dioica* Linn.**) to flax and other lignocellulosic fibres. The stress/strain curve of stinging nettle fibres shows that they have a linear behaviour. The average tensile properties are a Young's modulus equal to 87GPa, a tensile strength equal to 1594MPa and a strain at failure equal to 2.11% [Bodros Edwin and Baley Christophe, Study of the tensile properties of stinging nettle fibres (*Urtica dioica*), *Mat Lett*, 2008, **62**(14), 2143-2145].

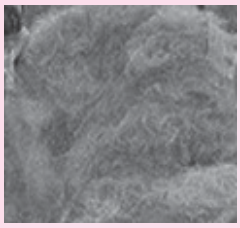
Cement-bonded composite boards with *Arhar* stalks

The scientists at Central Building Research Institute, Roorkee, India carried out studies to explore the possibility of making cement-bonded composite building products using *Arhar* [***Cajanus cajan* (Linn.) Millsp.**] stalks. The water extractive of *arhar* stalks is slightly acidic, *p*H value around 6.5. It was found that the extractive adversely affect the cement hydration and strength development processes. The increase in setting time varied from 25 to 130% when extractive content was from 0.5 to 2% by weight of cement. The 28-day compressive strength reduced by 13 to 20% at 1-2% concentration of extractive powder. Further, studies showed that these effects

could be overcome by adopting suitable measures like cold water extraction and/or by use of an accelerator. A dose of 2% calcium chloride, by weight of cement, could offset the effect of 1% concentration of *arhar* extractive. The cement-bonded composites were prepared by varying the flakes content from 0 to 32%, by weight, in the flakes-cement mix using a casting pressure of 3MPa and demoulding time up to 10h. The results showed that cement composites with bending strength >9.0MPa and internal bond strength >0.6MPa could be made using *arhar* stalks as a reinforcing material. The strength properties of *arhar* stalks -cement composites were found to satisfy the minimum requirements of International Standard, ISO:8335-1987n [Aggarwal LK, Agrawal SP, Thapliyal PC and Karade SR, Cement-bonded composite boards with *arhar* stalks, *Cement Concr Comp*, 2008, **30**(1), 44-51].

Surface treatment of coir fibres

Coir (***Cocos nucifera* Linn.**), an important lignocellulosic fibre, can be incorporated in polymers like polyacrylate in different ways for achieving desired properties and texture. But its high level of moisture absorption, poor wettability and insufficient adhesion between untreated fibre and the polymer matrix lead to debonding with age. In order to improve the above qualities, adequate surface modification is required. Hence, the scientists at University of Dhaka, Dhaka and Institute of Nuclear Science and Technology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh worked on fibre surface modification by ethylene



dimethylacrylate (EMA) and cured under UV radiation. Pretreatment with UV radiation and mercerization were done before grafting with a view to improve the physico-mechanical performance of coir fibres. The effects of mercerization on shrinkage and fibre weight losses were monitored at different temperature and alkali concentration. It was observed that fibre shrinkage is higher at low temperature and 20% alkali treated coir fibres yielded maximum shrinkage and weight losses. It was found that higher shrinkage of the polymer grafted fibre showed enhanced physico-mechanical properties. The grafting of alkali treated fibre showed an increase of polymer loading (about 56% higher) and tensile strength (about 27%) than 50% EMA grafted fibre. The fibre surface topology and the tensile fracture surfaces were characterized by scanning electron microscopy and were found improved interfacial bonding to the modified fibre–matrix interface [Rahman M Mizanur and Khan Mubarak A, Surface treatment of coir (*Cocos nucifera*) Fibres and its influence on the fibres' physico-mechanical properties, *Comp Sci Technol*, 2007, **67**(11-12), 2369-2376].

Manufacturing particleboard panels from Betel palm fibre

The scientists at National Pingtung University of Science and Technology, Pingtung, Taiwan and Oklahoma State University, Stillwater, USA investigated the use of Betel palm (***Areca catechu* Linn.**) to manufacture experimental particleboard panels. The panels were tested for their mechanical and physical properties according to the procedures defined by Chinese National Standards [Chinese National Standard (CNS), CNS-2215 Particleboard, Bureau of Standards, Metrology and Inspection, MOEA, Taiwan, ROC, 1999]. The highest modulus of elasticity, modulus of rupture, internal bond strength and screw holding strength values of the samples were found as 2180N/mm^2, 14.6N/mm^2, 0.78N/mm^2 and 600N/mm^2 for the panels made using 10% urea formaldehyde with a target density of 0.70g/cm^3, respectively. Overall physical and mechanical properties of both types of panels produced with and without adding wax into the mats resulted in accepted values. Based on the findings of the study, it appears that betel palm can be used to manufacture value-added panels without having any significant adverse influence on board properties [Lin Cheng Jung, Hiziroglu Salim, Kan Shu Min and Lai Hsien Wen, Manufacturing particleboard panels from betel palm (*Areca catechu* Linn.), *J Mat Proc Technol*, 2008, **197**(1-3), 445-448].

Mechanical properties of Kenaf fibres and Kenaf/PLA composites

The researchers at Miyagi National College of Technology, Natori, Japan explored the mechanical properties of kenaf fibre and also described the cultivation of kenaf and application to biodegradable composite materials. The unidirectional biodegradable composite materials were made from kenaf fibres and an emulsion-type PLA (Polyacetic acid) resin. Thermal analysis of kenaf fibres revealed that tensile strength of kenaf fibres decreased when kept at 180ºC for 60min. Therefore, biodegradable composites were fabricated at a molding temperature of 160ºC. The unidirectional fibre-reinforced composites showed tensile and flexural strengths of 223 and 254MPa, respectively. Moreover, tensile and flexural strength and elastic moduli of the kenaf fibre-reinforced composites increased linearly up to a fibre content of 50%. The biodegradability of kenaf/PLA composites was examined for four weeks using a garbage-processing machine. Experimental results showed that the weight of composites decreased 38% after four weeks of composting [Ochi Shinji, Mechanical properties of kenaf fibres and kenaf/PLA composites, *Mech Mat*, 2008, **40**(4-5), 446-452].

Preparation and characterization of long natural cellulose fibres from Wheat straw

Long natural cellulose fibres with properties suitable for textile and composite applications have been obtained from wheat straw. Hence, the researchers at University of Nebraska-Lincoln, Lincoln, Nebraska, USA studied the potential of using wheat straw as a source for long natural cellulose fibres for textile, composite and other fibrous applications. The presence of wax on the outer layer of the straw and a unique zip-like structure that locks individual fibres makes it difficult to obtain fibres from wheat straw using the common methods of fibre extraction. A novel pretreatment with detergent and mechanical force followed by an alkaline treatment was used to obtain high quality fibre bundles. The structure and properties of the fibres are reported in comparison to common cellulose fibres, cotton, linen and kenaf. Wheat straw fibres have coarser (wider width) single cells and lower crystallinity than cotton, linen and kenaf. The breaking tenacity (force at break) of wheat straw fibres is similar to kenaf but lower than that of cotton and linen, % breaking elongation is similar to linen and kenaf but lower than cotton and Young's modulus of the fibres is similar to cotton but lower than that of linen and kenaf [Reddy N and Yang Y, Preparation and characterization of long natural cellulose fibres from wheat straw, *J Agric Food Chem*, 2007, **55**(21), 8570-8575].

Natural cellulose fibres from Sorghum leaves and stems

The scientists at University of Nebraska-Lincoln, Lincoln, Nebraska, USA explored possibilities of using Sorghum leaves and stems to produce natural cellulose fibres with properties suitable for composite, textile and other high-value fibrous applications. The leaf and stems fibres produced are multicellular and have similar cellulose contents. The breaking tenacity and elongation of the fibres are similar to that of natural cellulose fibres such as kenaf and cornstalk fibres. However, the sorghum fibres have a modulus of about 113 g/denier (15 GPa) similar to the modulus of cornstalk fibres but higher than that of cotton and cornhusk fibres. At least 7 million tonnes of natural cellulose fibres can be produced by using the sorghum stems and leaves available as byproducts every year. Using the sorghum byproducts as a source for cellulose fibres will help to add value to the sorghum crops and also make the fibre industry more sustainable [Reddy N and Yang Y, Structure and properties of natural cellulose fibres obtained from sorghum leaves and stems, *J Agric Food Chem*, 2007, **55**(14), 5569-5574].

Plantain fibre bundles isolated from Colombian agro-industrial residues

Comestible fruit production from family Musaceae is an important economical activity in developing countries like Colombia. However, it generates a large amount of agro-industrial residues. Some of them are a potential resource of natural fibres, which can be used as reinforcement for composite materials. In a research work, a series of commercial plantain (*Musa AAB*, cv. 'Dominico Harton') fibre bundles extracted from pseudostem, leaf sheath and rachis agricultural wastes were analyzed by scientists at Colombia and Spain. Mechanical decortication and biological retting processes were used during fibre extraction. No significant differences in composition of vascular bundles were observed for both extraction processes. Gross morphological characteristics and mechanical behaviour have been evaluated. Conducting tissues with spiral-like arrangement are observed attached to fibre bundles. This fact suggests a big amount of these tissues in commercial plantain plants. Both used extraction methods are not enough to remove them. Pseudostem fibre bundles have higher specific strength and modulus and lower strain at break than leaf sheath and rachis fibre bundles, having values comparable to other lignocellulosic fibre bundles such as flax, jute, ramie or hemp. Thus, plantain fibre bundles can be useful as reinforcement of composites [Gañán Piedad, Zuluaga Robin, Restrepo Adriana, Labidi Jalel and Mondragon Iñaki, Plantain fibre bundles isolated from Colombian agro-industrial residues, *Bioresour Technol*, 2008, **99** (3), 486-491].

Dual antimicrobial and blood repellent finishes for Cotton hospital fabrics

Antimicrobial and blood repellent finish has been applied by scientists at Department of Textile Technology, PSG College of Technology, Coimbatore, India to cotton fabrics used for surgical gowns, bed linens and drapes to reduce the surgical site infections. The extract of neem was applied to the fabric for imparting antimicrobial activity by pad-dry-cure method. The neem treated fabric was then imparted blood repellency through two different techniques, namely by treatment with fluoropolymer (3, 4 and 5% owf) using pad-dry-cure method and by 'sputter deposition of teflon' technique using argon plasma. The antimicrobial activity is found to be higher for teflon deposited fabric than for the fluoropolymer finished fabric. Blood repellency increases with the higher concentration of fluoropolymer and the highest repellency for the teflon deposited fabric is observed at 80W power and 20 min exposure in the plasma chamber [Thilagavathi G and Kannaian T, Dual antimicrobial and blood repellent finishes for cotton hospital fabrics, *Indian J Fibre Text Res*, 2008, **33** (1), 23-29].

Quality of chemically modified Hemp fibres

Hemp fibres are very interesting natural material for textile and technical applications now. Applying hemp fibres to the apparel sector requires improved quality fibres. In a study by researchers at Textile Engineering Department, Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia, hemp fibres were modified with sodium hydroxide solutions (5 and 18% w/v), at room temperature and boiling temperature, for different periods of time and both under tension and slack, in order to partially extract noncellulosic substances and separate the fibre bundles. The quality of hemp fibres was characterised by determining their chemical composition, fineness, mechanical and sorption properties. The modified hemp fibres were finer, with lower content of lignin, increased flexibility and in some cases tensile properties were improved. An original method for evaluation of tensile properties of hemp fibres was developed [Kostic Mirjana, Pejic Biljana and Skundric Petar, Quality of chemically modified hemp fibres, *Bioresour Technol*, 2008, **99** (1), 94-99].

Transglutaminase mediated grafting of silk proteins onto wool fabrics

Transglutaminases (TGase) have the ability to incorporate primary amines and to graft peptides (containing glutamine or lysine residues) into proteins. These properties enable transglutaminases to be used in the grafting of a range of compounds including peptides and/or proteins onto wool fibres, altering their functionality. Researchers at Italy and UK investigated the transglutaminase mediated grafting of silk proteins into wool and its effect on wool properties. A commercial hydrolysed silk preparation was compared with silk sericin. The silk sericin protein was labelled with a fluorescent probe which was used to demonstrate the efficiency of the TGase grafting of such proteins into wool fibres. The TGase mediated grafting of these proteins led to a significant effect on the properties of wool yarn and fabric, resulting in increased bursting strength, as well as reduced levels of felting shrinkage and improved fabric softness. Also observed was an accumulation of deposits on the surface of the treated wool fibres when monitored by SEM and alterations in the thermal behaviour of the modified fibres, in particular for mTGase/sericin treated fibres which, with the confocal studies, corroborate the physical changes observed on the treated wool fabric [Cortez João, Anghieri Anna, Bonner Philip LR, Griffin Martin and Freddi Giuliano, Transglutaminase mediated grafting of silk proteins onto wool fabrics leading to improved physical and mechanical properties, *Enzyme Microb Technol*, 2007, **40** (7), 1698-1704].

The use of Kapok fibres for enrichment cultures of lignocellulose-degrading bacteria

Experiments were conducted at Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden to explore the possibility of using kapok fibres for enrichment or purification of wood-degrading bacteria. During experiment solid pine wood and kapok fibres were incubated with mixed bacterial consortia containing erosion or tunnelling bacteria demonstrated that evidence of bacterial attack could be seen much earlier in the kapok fibres. Kapok fibres are lignified and therefore, show a chemical resemblance to wood fibres. Preparation of wood sections for microscopy is rather time-consuming, whereas kapok fibres can be observed easily without sectioning [Nilsson Thomas and Björdal Charlotte, The use of kapok fibres for enrichment cultures of lignocellulose-degrading bacteria, *Int Biodeter Biodegrad*, 2008, **61** (1), 11-16].

Chitosan contribution on wool treatments with enzyme

Researchers at Spain, Serbia and Montenegro observed in a study that the application of biopolymer chitosan (CHT) on wool fabrics before the enzymatic treatment promotes an increase of the weight loss. In order to deep on the role played by CHT, several experimental conditions were selected according to a hybrid experimental design and different parameters, such as weight loss and shrink-resist properties, have been controlled. To enhance the CHT sorption on the wool fibre surface, wool was submitted previously to a water-vapour low-temperature plasma treatment. The weight loss results reveal that the enzyme effect increases by increasing the CHT concentration applied to untreated wool. However, CHT concentration does not have any influence when wool has been previously treated with plasma. It is deduced that the surface free energy of wool fibres plays an important role on the enzyme activity. Therefore, the results obtained reveal that the main contribution of CHT on hydrophobic surface of untreated wool fibres is to confer hydrophilicity to wool. Furthermore, CHT tends to coat the wool fibres by film formation reducing apparently the fibre damage promoted by enzyme treatment and also reducing the wool shrinkage [Vílchez S, Manich AM, Jovancic P and Erra P, Chitosan contribution on wool treatments with enzyme, *Carbohydr Polym*, 2008, **71** (4), 515-523].

Performance of Ramie fibre modified with ethylenediamine

Ramie, also called China grass [***Boehmeria nivea* (Linn.) Gaud.**], is a hardy perennial herbaceous plant of the Urticaceae family. Researchers in China conducted studies and incorporated the chelate molecule, ethylenediamine, onto the surface of ramie fibre via sequential reactions of the hydroxyl groups on ramie fibre with epichlorohydrin followed by the chelating agent. The performance of the modified material (CelNH) was characterized by Fourier transform infrared spectroscopy, X-ray diffraction, scanning electron micrographs, thermogravimetry analysis, UV-Vis and elemental analysis. Results showed that the excellent characteristics of the raw fibre were still remained after modification although the crystallinity of the modified fibre decreased. The modification parameters were optimized as the concentration of ethylenediamine of 0.75 mol/l, the temperature of 50°C and the reaction time of 5 hours. Meanwhile, the dye of C.I. reactive red 2 was used to study the dyeability of the raw and the modified fibres. The colour strength and the dye uptake of the modified fibre increased obviously with an increase in the nitrogen contents in CelNH. The colour strength and the dye uptake of the modified fibre can be controlled by changing the extent of surface modification of raw ramie fibre [Liu Zhao-Tie, Yang Yani, Zhang Lili, Sun Ping, Liu Zhong-Wen, Lu Jian, Xiong Heping, Peng Yuande and Tang Shouwei, Study on the performance of ramie fibre modified with ethylenediamine, *Carbohydr Polym*, 2008, **71** (1), 18-25].

Fast wood fibre esterification

A method for modifying wood fibre with non-solvent media, to produce ready-to-use hydrophobic fibre suitable for use in composites, has been proposed by researchers of Mexico based on their research findings. The chemical modification was achieved by means of a consecutive reaction (cellulose/oxalic acid/cetyl alcohol) performed in a mixing chamber, at 110 °C and 30 rpm. The reaction product was washed by extraction with water and hexanes and then characterized by using spectroscopic techniques (FTIR and ^{13}C CPMAS-NMR). The results from these analyses revealed groups, indicating that the esterification reaction was successful. The thermal stability of the treated samples was studied by thermogravimetric analysis; the modified fibre exhibited an increased thermal stability relative to the unmodified fibre, this increase may be related to both the formation of ester groups and the grafting of the cetyl radicals [Gardea-Hernández G, Ibarra-Gómez R, Flores-Gallardo SG, Hernández-Escobar CA, Pérez-Romo P and Zaragoza-Contreras EA, Fast wood fibre esterification. I. Reaction with oxalic acid and cetyl alcohol, *Carbohydr Polym*, 2008, **71** (1), 1-8].

Grafting of ethylcellulose microcapsules onto Cotton fibres

Treatment of cotton with ethylcellulose (EC) microcapsules was investigated by researchers at Chemistry Department, University of Ploiesti, Ploiesti, Romania and Textile Department, University of Maribor, Maribor, Slovenia. EC microcapsules containing Rosemary oil were obtained by phase separation method. The surface and morphology of microcapsules were characterized by scanning electron microscopy (SEM). Microcapsules with a regular spherical shape in the 10-90 μm size range were prepared and grafted onto cotton using the crosslinking reagent 1,2,3,4-butanetetracarboxylic acid (BTCA) in the presence of catalysts. The influence of the two catalysts, cyanamide (CA) and *N*,*N*'-dicyclohexylcarbodiimide (DCC) on curing efficiency (grafting) was investigated. SEM and Fourier transform infrared spectroscopy were used to study the formation of ester bonds between BTCA and hydroxyl groups of cotton and/or hydroxyl groups of EC. When DCC was used as a catalyst, the esterification took place slowly at room temperature. In the case of CA, the cotton was cured at 110°C for several minutes. After 2 min curing, the microcapsules, which kept their original shape, were bonded to the cotton fibres. Increasing the curing time altered the microcapsule shell. Grafting and crosslinking reactions of the thermofixed EC microcapsules onto cotton were proposed [Badulescu Roxana, Vivod Vera, Jausovec Darja and Voncina Bojana, Grafting of ethylcellulose microcapsules onto cotton fibres, *Carbohydr Polym*, 2008, **71** (1), 85-91].