Editorial

Editorial for the special edition on 'Polysaccharide Materials' of the Journal of Renewable Materials

Our society is amidst a technological revolution towards a sustainable economy, with a focus on the development of biobased materials and products that will be able to substitute petroleum-derived ones in virtually all sectors. In this context, polysaccharides represent the main renewable resource from biomass for the production of biofuel and materials. The total annual production of biomass in the biosphere is estimated as 100 billion tonnes per year (*Science, 281, 237, 1998*). Polysaccharides account for approximately 75% of this biomass, from which only 3.5% is currently exploited for food and other applications. These large figures indicate the potential of polysaccharides arising from plant biomass to virtually fulfill a significant portion of the increasing needs for bioenergy and materials in a sustainable manner.

In this **special issue** we are proud to offer a flavour of the research being currently performed around the world on the technological transformation of polysaccharides into valuable materials and products. Cellulose nanostructures, such as **cellulose nanocrystals** and **nanofibres**, offer a unique combination of physico-mechanical properties and versatility for further chemical modification, which allows their potential utilization as nanopaper, fibres, dispersants, foams, and as reinforcements in composite applications. **Chitin** and **chitosan** possess valuable inherent functionalities (e.g. antimicrobial activity) and offer great potential for chemical modification due to the presence of amino groups. Finally, **thermoplastic starch** has been extensively developed in the last decade as a commodity biobased polymer, able to substitute conventional oil-based plastics in a wide range of applications.

Polysaccharides are found in nature as the main components of eukaryotic cell walls (providing structural stability to such organisms), and as energy-storage biomolecules (involved in their nutritional pathways). Cellulose is the most abundant polysaccharide in nature and constitutes the main structural component of plant cell walls in the form of microfibrils. Hemicelluloses and pectins are also present in plant cell walls as polymeric matrices, interconnecting the cellulose microfibrils and thus conferring the typical composite structure in such cell walls (e.g. wood). Chitin (and its deacetylated derivative, chitosan) is widely abundant in nature as a main component in the fungal cell wall and in the exoskeleton of arthropods (insects and crustaceans). The structure of chitin is comparable to that of cellulose, and it also provides structural stability to such organisms in the form of fibrils and whiskers. Finally, starch is the main storage polysaccharide and widely available in cereal grains and in tubers. Starch is a fundamental part of the human and animal diet, but also a valuable renewable resource to produce commodity thermoplastics.

Polysaccharides are arguably the most structurally-complex biomacromolecules, in terms of the stereochemistry of the constituent sugars and the multiple linkage/branching possibilities, which ultimately form an extremely complex molecular architecture. The structural heterogeneity of native polysaccharides at the macromolecular level and their complex hierarchical organization from the nano- to the macroscopic scales imposes major difficulties for their biotechnological extraction and fractionation from their native sources. However, this structural complexity does offer exciting possibilities and great versatility for the development of functional carbohydrate-based materials in a wide range of applications, from commodity structural materials to high-value components in biomedical, sensor or electronic devices. Numerous activities are currently being been carried out for the exploitation of renewable polysaccharides into valuable materials. These tasks involve their extraction and fractionation within the biorefinery context, their chemo-enzymatic modification into valuable carbohydrate derivatives, and their processing using nanotechnologies into end-products with tailored applicabilities. One of the main advantages of polysaccharide-based materials is their sustainability throughout heir life cycle, since they arise from renewable resources, they can be modified and processed using clean technologies and they are biodegradable.

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This special issue is introduced by two **perspective articles** that review the current trends for the processing of starch and cellulose, arguably the most important polysaccharides from an application point of view. A summary of the recent developments for the successful thermo-mechanical processing of thermoplastic starch, including reactive extrusion, is presented by *Xie* and coworkers at the Australian Institute for Bioengineering and Nanotechnology. On the other hand, the recent developments on the preparation of cellulose nanowhiskers from bacterial cellulose and their incorporation into advanced fibre and nanocomposite formulations via melt compounding using electrohydrodynamic processing (electrospinning) is described by *Martínez-Sanz* and colleagues at the Spanish Institute for Agrochemistry and Food Technology. A **short communication** by *Carvalho* (University of São Paulo, Brazil) offers a valuable comparative of the morphology of cellulose nanocrystals (CNCs) and cellulose microfribils (MFCs) extracted from Eucalyptus. Finally, three **research articles** are included as excellent examples on the current research being performed on the modification, application and biodegradability of polysaccharide-based materials. The development of chitosan-based coatings for cellulose surfaces, with potential application as packaging material with enhanced barrier properties and biodegradability is presented by *Bordenave* and collaborators from a pan-European consortium. The structural and film-forming properties of starch derivatives (e.g. triacetyl starches) from different biological origins are evaluated by *Koch* and collaborators in Sweden. Finally, the degradative behaviour of starch-based composites reinforced with lignucellulosic fibres under different environments to ensure the durability and biodegradability of such biobased materials is described by a Spanish-Swedish team (*Moriana et. al*).

I really hope that the readers of the *Journal of Renewable Materials* enjoy this special issue on 'Polysaccharide Materials', and that the excellent scientific contributions here collected inspire the technological development of native polysaccharides from biomass into high-performance carbohydrate-based materials in our transition towards a sustainable society.

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