

Preface

Global warming and the increasing demand for raw materials make the transition to a sustainable era of energy and materials a necessity. The development of new chemical processes for intermediates not based on coal and oil is becoming essential [1]. Our economic system is currently built on finite resources, for which we will sooner or later need a substitute. Biomass is considered one of the possible alternatives to develop in the near future, which could contribute in the immediate to increase the lifetime of available fossil forms of carbon. The term “biomass” means any plant-derived organic matter available on a renewable basis, including energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood waste and residues, aquatic plants, animal waste, municipal waste, and other waste materials [2]. Biomass resources can be used to produce an array of energy-related products including electricity, liquid, solid, and gaseous fuels, heat, chemicals, and other materials of high-added value. Biomass renewable energy is also considered relatively “sustainable,” since the related environmental and social impact is normally more benign than that of fossil or nuclear fuels. However, large areas of land are necessary to grow energy crops, which introduce some concerns about the impact of using land for this purpose when it should first be used to produce food. Only the left-overs and wastes from agriculture should be exploited as a fuel source for the manufacture of carbon-based materials (e.g., commodities so much needed by our civilization such as cloths, detergents, paints, pesticides, herbicides, vehicles, and drugs). This observation should stimulate the use of solar energy and sea water to produce electricity and water suitable to irrigate desert land for food and more biomass production. Such projects would provide work for many people in poor regions of the world.

Combustion of biomass and biomass-derived fuels can produce air pollution; how serious this impact is will depend on how carefully the resource is managed. Today, a wide variety of production and conversion methods exist, each with different environmental impacts. However, renewable energy sources can be considered sustainable in the sense that they cannot come to an end, although often, as is the case of biomass, they require an “intelligent” management (adequate use of water and readily degradable pesticides) if they are to be used sustainably.

By integrating the production of higher-value chemicals into fuels production, the overall efficiency of all energy-related products will be improved, thus matching the goals of ecological restoration and economic development (for a discussion of this topic, see <http://www.nrel.gov/biomass/biorefinery.html>) [3]. Producing fuels and chemicals from biomass is not a new concept. Vegetable oil, cellulose (wood), ethanol, methanol, and many other biomass-based chemicals have been in use since more than two centuries to make solvents, paints, adhesives, synthetic cloths and so on. By the late 1960s, when petrochemicals began to dominate the market, many of these bio-derived products were displaced by petroleum derivatives. The energy crisis of the 1970s generated a renewed interest in the synthesis of fuels and materials from bioresources, but this interest decreased immediately in the subsequent decade as the oil price abated. Presently, economic, geopolitical, and environmental concerns are responsible for the renewed interest in biomass exploitation. In addition, it is noteworthy that new advances in biotechnology and chemical processes have significantly reduced the costs of producing biochemicals; many biochemicals can already compete economically with petrochemicals. When environmental benefits are considered, biochemicals may have even lower production, handling, use and risk management costs than their petroleum-based counterparts. Today, biomass can substitute petroleum feedstocks in the production of most fuels and chemicals. Nevertheless, different processes must be developed; fossil fuels are hydrocarbons, i.e., various combinations of carbon and hydrogen; biomass components are mainly carbohydrates, i.e., various combinations of carbon, hydrogen, and oxygen. The shift from petroleum hydrocarbons to oxygenated bio-based feedstocks may create new opportunities in the chemical and biochemical industries. Important building blocks may be produced from sugars and these can be transformed into new families of useful molecules [4]. The presence of oxygen makes it more challenging to synthesize some products and easier to prepare others; considering the wide range of types of biomass should make it possible to make new and valuable products not made from petrochemicals. However, to avoid recreating the environmental problems arising from many of the processes in use today, it is essential that the use of renewable biomass is complemented by the application of green chemical processes and technologies to generate environmentally compatible products based on green and sustainable supply chains. Currently, there is growing international interest in the development of safer alternatives to problematic chemicals, materials, and products. For example, a central goal of the European Community, as expressed by the new regulation on Registration, Evaluation, and Authorization of Chemicals (REACH), is the substitution of problematic chemicals with safer alternatives (<http://www.reachcentrum.org>). Clean technology concerns the reduction of waste from an industrial chemical process to a minimum, and it requires the rethinking and redesign of many current chemical processes.

The two books, Vols. 294 and 295, are based on the lectures presented at the Carbohydrates as Organic Raw Materials (CORM) V conference held in Lisbon (January 20–23, 2009), organized and chaired by Amélia Pilar Rauter (University of Lisboa) and Yves Queneau (University of Lyon, INSA Lyon), with the collaboration of Frieder Lichtenhaler (Technische Universität Darmstadt) as Honorary Chairman, who has also started these meetings in 1990. A series of conferences took place until

1997. This led to three monographs “Carbohydrates as Organic Raw Materials” by VCH-Weinheim: Vol. I edited by F.W. Lichtenthaler (1991), Vol. II edited by G. Descotes (1993), Vol. III edited by H. van Bekkum, H. Röppler, and A.G.J. Voragen (1996), and to a fourth volume (Vol. IV) by WUV-Univ. Vienna edited by W. Praznik and H. Huber (1998). After 12 years, the relaunch of CORM in Lisbon brought new insights into the role of carbohydrates for sustainable development.

The contributions presented in this first volume entitled “Carbohydrates and Sustainable Development, Part 1, Renewable Resources for Chemistry and Biotechnology” demonstrate that new knowledge has been collected during the last decade opening many opportunities for better biomass exploitation. Sucrose extracted from sugarcane and sugar beat can be much more than a source of biofuels (ethanol). It can be converted into valuable synthetic intermediates such as bioethylene, 1,2-propyleneglycol, 5-(hydroxymethyl)furfural, and levulinic acid and can be used as glycosyl donor in the enzyme-catalyzed glycosidation to efficiently produce biopolymers and antigenic carbohydrates (Sucrose: A Prospering and Sustainable Organic Raw Material and Sucrose-Utilizing Transglucosidases for Biocatalysis). Natural or synthetic fructose-based oligomers are promising compounds toward functional foods (food additive for better health) (Difructose Dianhydrides (DFAs) and DFA-Enriched Products as Functional Foods). Trees, seaweeds, cereal production left-overs such as straw and brans, and olive pomace constitute the most abundant source of carbon as alternative to oil and coal. Celluloses and hemi-celluloses found in these raw materials can be converted into a large variety of chemicals and materials, some of them with high-added value (Development of Agriculture Left-Overs: Fine Organic Chemicals from Wheat Hemicellulose-Derived Pentoses, Cellulose and Derivatives from Wood and Fibers as Renewable Sources of Raw-Materials, and Olive Pomace, a Source for Valuable Arabinan-Rich Pectic Polysaccharides); seaweeds are now a source of green surfactants (Oligomannuronates from Seaweeds as Renewable Sources for the Development of Green Surfactants), and polysaccharides from diverse origins can be shaped to new materials for catalysis, absorption, and remediation (From Natural Polysaccharides to Materials for Catalysis, Adsorption, and Remediation). The second volume, which shows the diversity of reactions and syntheses based on available carbohydrate-based resources, is entitled: “Carbohydrates and Sustainable Development, Part 2, A Mine for Functional Molecules and Materials”.

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