Biomass and Bioenergy

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Umer Rashid
Editors

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## Applications

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# Foreword

There are many global resources available to meet the growing energy demand. Global reserves of petroleum lie around 1.033.2 billion barrels, natural gas around 5.141.6 trillion cubic feet, and coal around 1.087.2 billion tons. The energy sources used for generating electrical power on global basis are nuclear (17.7 %), natural gas (14.8 %), coal (38.4 %), oil (9.3 %), hydro (18.4 %), and wood + refuse + renewable (1.4 %). The common renewables are solar, wind, biomass, energy from waste, geothermal, hydro, wave and tidal, and ocean thermal. Out of these energy sources, renewable energy is among the fastest growing. Annual turnover has reached 30 billion Euros or about 50 % of the world market. Recycling, energetic valorisation, prevention and organic valorisation are attracting great attention worldwide. One of the sources of renewable energy is biomass. In many developing countries these sources of fuel are a large proportion of the energy available.

A substantial increase in the production of bioenergy from biomass originating from different sources offers opportunities to reduce greenhouse gas emissions and helps to diversify use of resources in order to provide more secure energy supply. It can create additional income for agricultural land owners, thereby paving way for promoting new economic perspectives among rural communities. A greater production of bioenergy can provide incentives for greater use of agrilands as well as forests, which can counteract the aims of waste reduction policies. However, increase in bioenergy production can at the same time pose a risk of additional environmental pressure on plant diversity, soil use, and water resources. There are ways to overcome these disadvantages by growing low-impact bioenergy crops, forbidding ploughing of pastures, and bringing down the intensity of residue extraction depending upon the soil conditions. Application of sustainably fit environmental regulations is important if we want to increase bioenergy production. There is a great need for an assessment of economics and logistics in this direction.

This book provides detailed insight covering selected chapters on topics like non-wood renewable materials such as oil palm, bamboo, rattan, bagasse, and kenaf; upgrading of oil palm as added product a long-identified sustainable source of renewable energy which can reduce the dependency on fossil fuels as the main source of the energy supply; biodiesel synthesis using transesterification of

triglycerides in the presence of catalyst and alcohol, and application of single-step process for biodiesel synthesis from microalgae; electrochemically active biofilms as fascinating biogenic tools for microbial fuel cells, nanomaterial synthesis, bioremediation, and bio-hydrogen production as synthesis of these nanoparticles as well as nanocomposites and bio-hydrogen production does not involve any energy input which make these approaches highly efficient; microalgal biomass as a source of renewable energy; critical analysis of the current situation and future needs for technological developments in the area of producing liquid biofuels from lignocellulosic biomass as a future alternative for bioethanol production; utilisation of sawmill by-product for making cellulose and its valuable derivatives which is normally used for direct combustion; ultimate valorisation of oil palm biomass in relation to biorefinery approach; polylactic acid-based kenaf biomass synthesised via ring opening polymerisation for a production of eco-friendly products which can replace the petroleum-based products; chemical functionalisation of natural cellulosic fibres through free radical-induced graft copolymerisation technique for green polymer composites applications so as to overcome the disadvantages associated with these fibres; recent applications of kapok fibre and its use as a desirable template material or supported candidate such as for catalyst carriers; abaca fibre as a renewable bioresource for industrial uses and other applications in environmental protection specifically for soil conservation and control of soil erosion as well as for the preparation of cellulose nanocrystals as components of the composites; recent advances in the realm of the extraction of nanofibrillated cellulose from lignocellulosic fibres as sustainable nanofillers with broad potentials use; termites from pest to biopolymer derivatives extractor as efficient converters of wood into sugars and for making numerous biochemicals and biofuels, with recent conversion methods of biochemicals from lignocellulosic biomass for application enablement and commercialisation, laying special emphasis on termite lignocellulolytic system; and last but not least applications of biomass-derived catalyst.

I am sure that the chapters presented in this book will encourage further discussion and research and development on biomass and biofuel production for human use, taking into account the environmental sustainability. It is a welcome addition to the existing information available on this topic. The main focus has been on Indonesia, Malaysia, Philippines, Thailand, Bangladesh, India, and Pakistan where large populations have been and are still using biomass as a source of energy. The authors and the editors of this book have done a good job in covering the diverse aspects of biomass/biofuel production and multiple uses of cellulosic materials.

Izmir, Turkey Münir Öztürk

# Preface

Recently technological advances, consumer demands, and environmental consciousness lead to better application of available biomass for environmental sustainability. Biomass is abundantly available worldwide as a cheap and extremely important renewable energy source of materials for producing energy which can be used for different applications at the cost competitive rates. In recent years, the use of biomass and bioenergy has been widely adopted worldwide to produce biofuels, biogas, biocatalyst, bio-composites, bioplastics, green chemical products, cellulose textiles, etc. However, there are still important issues and applications of biomass to be explored. The number of biomass energy applications is expanding rapidly which motivated us to work in this area to compile resources in the form of the present book.

This volume (second of the book series *Biomass and Bioenergy*) attempts to give an overview of the current applications of biomass and bioenergy to scientists, researchers, and industrial people in the field of material science, chemical engineering, forestry, and mechanical engineering to understand where and how biomass and bioenergy can be utilised, how it works, and the advantages as well as the limitations. Overall, biomass is seen as a potential material, and this book covers the utilisation of biomass in different applications such as hydrogen production, bioethanol, biodiesel, biofuel, bioenegry, biofilms, renewable energy, nanocellulose, green composites, and catalysts. With this book we tried to provide some new insights into the readers about applications of biomass and bioenergy, which were not explored in previous published works.

We are highly thankful to all the contributors from around the world, who helped us to shape our idea in the form of a much needed volume by following our instructions and feedback. We greatly appreciate their commitment.

We thank Springer-Verlag team for initiating and supporting our book idea and their unstinted cooperation at every stage of the book production.

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**Dr. Mohammad Jawaid, Ph.D.** is currently working as Fellow Researcher (Associate Professor), at Biocomposite Laboratory, Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia, Serdang, Selangor, Malaysia and also Visiting Professor at Department of Chemical Engineering, College of Engineering, King Saud University, Riyadh, Saudi Arabia since June 2013. Previously he worked as Visiting Lecturer, Faculty of Chemical Engineering, Universiti Teknologi Malaysia (UTM) and also worked as Expatriate Lecturer under UNDP project with Ministry of Education of Ethiopia at Adama University, Ethiopia. He received his Ph.D. from Universiti Sains Malaysia, Malaysia. He has more than 10 years of experience in teaching, research, and industries. His area of research includes natural fibers based polymer composites, hybrid composites, nanocomposites, nanocellulose, etc. So far he has published 1 book, 10 book chapters, and 95 ISI journal papers. He is also the Deputy Editor-in-Chief of *Malaysian Polymer Journal* and reviewer of several high impact ISI journals.

**Dr. Umer Rashid, Ph.D.** is working as a Senior Fellow Researcher at Universiti Putra Malaysia, Malaysia since 2011. He has obtained his M.S. in Chemistry in 2003, from the University of Agriculture, Faisalabad, Pakistan and then completed his Ph.D. degree also from the University of Agriculture, Faisalabad, Pakistan in 2009 in the field of Analytical Chemistry. During his Ph.D. he worked as a Visiting Scientist in the Food and Industrial Oil Research Group at the USDA in Peoria, IL, USA. He is also the recipient of 2007 The Industrial Oil Products Division Student Excellence Award by Industrial Oil Products Division of the American Oil Chemist's Society (AOCS), USA. He completed his Post Doctorate in the field of Green Chemistry from Universiti Teknologi PETRONAS, Malaysia from 2010 to 2011. The focus of his research has been on the production and characterisation of novel feedstocks for biodiesel production. He has produced 92 research papers in internationally recognized ISI journals, including five book chapters with international publishers. Currently, he is working on the synthesis of heterogeneous catalyst from carbon based sources for the utilisation of high free fatty acid feedstocks for biodiesel production.