

Preface

World War II saw the onslaught of the chemical industries on a global scale. In fact, the chemical industry was perceived as a panacea to improve the everyday life and bring in new comforts and styles for the human beings. Meanwhile, over this decades-long period, the chemicals have resulted in all possible environmental and human health damages which are beyond repair even in the time to come. Most of the impacts, such as carcinogenicity, mutagenicity and teratogenicity are proliferating to such an extent that the countries have to spend billions as a health cost to repair these damages. Later on, “green chemistry,” also known as clean chemistry or benign and sustainable chemistry came on the chemical industry scene. Green chemistry refers to “the design of chemicals and formulation of processes that reduce the risk to humans and minimize environment pollution.” Green chemistry traces back several decades and can be linked to impactful environmental activists, such as Rachel Carson. Her 1962 publication, “Silent Spring,” helped direct the public’s awareness to pesticides and their ties to environmental pollution. As reflected in the previous decade spanning to today, there has been a shift in the emergence of green chemistry trends. As eco-awareness spreads to the consumer market and as the hazards of certain materials and chemicals become better known, companies and manufacturers are working to revamp the way they use and/or produce chemicals in their products. Eventually, this trend has been also parallelly taken over by the interest in biochemicals, that is, to produce chemicals using biological processes derived from plants, microorganisms and other living organisms. Biochemicals derived from biomass are generally obtained through industrial fermentation processes that make efficient use of a broad range of microorganisms to produce high-value fine chemicals, bulk chemicals, enzymes for use in pharmaceuticals through bio-catalysis, and a broad range of industrial chemicals (e.g., insect repellants, solvents, plastics, antibiotics, vitamins, and food additives, among others).

Another facet of the chemical industry has been its large-scale dependence on petroleum-based chemicals, and it is one of the many pressing challenges facing our planet. We can free ourselves from the dependency of petroleum industry-based feedstock through the bio-revolution. In this pursuit, opportunities to develop new and

innovative bio-products and bio-processes are expanding every day. According to the Future Bio-Pathways Report released in February 2011, there are dynamic growth opportunities to develop new products (e.g., cellulose-based) that can be converted into bio-chemicals and used in novel ways, such as making bulletproof vests, food additives, and greener tires. Opportunities also exist to convert older, smaller-scale pulp mills to produce a range of bio-chemicals to serve niche markets. The potential market size for bio-chemicals over the next 10 years is confounding and exceeds that of the traditional products industry. According to the Organization for Economic Co-operation and Development (OECD), the bio-economy will contribute 1–14 new drugs per year, and will be responsible for 10 % of chemical production by 2030 (<http://www.biotech.ca/en/policy-matters/beyondmoose-and-mountains/bioeconomyfacts.aspx>). Worldwide demand for industrial enzymes is expected to reach U.S. \$4.4 billion by 2015, with a compound annual growth rate of 6 %.

The biochemicals offer a range of environmental and economic advantages. The population at large benefits from biochemicals through reduced pollution. The biochemicals are derived from materials abundant in nature which dramatically reduces the amount of pollution generated from the extraction and processing of crude oil. Products derived from plant/microbial matter is highly biodegradable and in most cases can be disposed of safely and inexpensively. The private sector also accrues benefits from biochemicals in several ways. Biochemicals provide an environmental compliance tool for manufacturers. Increasingly stringent regulations regarding the use and disposal of petroleum-based chemicals are raising the administrative cost of these materials for manufacturers. Earlier, the manufacturers have often substituted a petrochemical not on the Toxic Release Inventory (TRI) to avoid environmental regulations only to discover that a later version of the TRI included the substitute petrochemical. Substituting biochemicals can be a permanent solution to the regulatory problem. The economics of replacing petrochemicals with biochemicals are increasingly favorable. Not only can a manufacturer save money by avoiding costly permits and compliance penalties, there is also a dramatic reduction in hazardous waste disposal costs. Companies using biochemicals in their manufacturing processes also can appeal to “green” consumers, an increasing portion of the market.

By 2025, biochemical is expected to make up 18 billion gallons, or \$50 billion worth, with 9–14 billion gallons coming from the biotechnological conversion of biomass. Through industrial biotechnology, carbon emissions can be cut and companies can work towards becoming greener and it would be good to tap into this potential. According to a recent life cycle assessment analysis by a research group at Institute for Energy and Environmental Research, Heidelberg, Germany, biomass as a sustainable carbon source is very important for the organic chemistry and hence biochemicals production.

During the last decade there has been a tangible shift from incremental innovation in the biochemicals field, where some specific steps in existing technologies were replaced to save energy or to make the overall production process more efficient, towards more radical innovation with the development of new production processes entirely based on renewable resources. This makes production of biochemicals today one of the rare technologies which might help to radically change

production chains in terms of sustainability along the whole product life cycle. Although currently the market share of biotechnology-produced bio-based chemicals is relatively small, the importance could grow very quickly depending on the substitution potential that bio-based materials have compared with their petrochemical counterparts. Some industrial biotechnology processes create the same molecules that are produced petrochemically. In these instances, the substitution could be complete, given that they are price-competitive. Other biotechnological processes lead to the creation of different compounds that have similar functionalities to petrochemical products, and in this case the biotechnology-derived molecules may not be suitable for a complete substitution of their petrochemical counterpart. They may nevertheless occupy or even create a niche within the overall market.

There are many publications which discuss about the production of compounds on large scale, such as biofuels, enzymes and organic acids from agro-industrial wastes. However, there is dearth of literature which discusses about the biovalorization of agro-industrial wastes into specialty biochemicals. The agro-industrial wastes have enormous potential to be converted to high-cost biochemicals, such as pharmaceuticals compounds (antibiotics, small peptides), antioxidants, aroma compounds, pigments, active food ingredients, exopolysaccharides and biosurfactants among others.

This book presents current and extensive information on biovalorization approach for the agro-industrial waste residues. Under each section, the chapters presents up to date and detailed information on agro-industrial waste residues and bioconversion technology to obtain biochemicals of economic importance. Implementation of biovalorization approach for agro-industrial wastes aims to mitigate pollution and other environmental problems and will promote economic benefits, such as production of biochemicals and reduction of waste management costs. This book covers the gap and will contain contributions from experts in field of processing of agro-industrial waste residues to various valuable biochemical products. This book will provide valuable information for academic researchers, graduate students and industry scientists working in industrial microbiology, biotechnology, bioprocess technology, waste management and the food industry.

We do hope that the book will provide a complete compilation of different biochemicals obtained from bioprocessing of residual biomass converging towards a bio-economy.

Québec, QC, Canada
Québec, QC, Canada
Curitiba, Paraná, Brazil

Satinder Kaur Brar
Gurpreet Singh Dhillon
Carlos Ricardo Soccol

Biotransformation of Waste Biomass into High Value
Biochemicals

Brar, S.K.; Dhillon, G.S.; FERNANDES, M. (Eds.)

2014, XV, 504 p. 53 illus., 26 illus. in color., Hardcover

ISBN: 978-1-4614-8004-4