RESEARCH ARTICLE

SUSTAINABLE UTILIZATION OF TROPICAL PLANT BIOMASS FOR BIO PRODUCTS, BIOCATALYSTS AND BIOREFIENRY

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Burgeoning population, fastest depletion of fossil fuel resources, alarming global climate change issues are the top most challenge to be addressed for a country to prosperous in energy, environmental and economic security. Greatest attention has been paid on renewable biomass for generation of alternative fuels, bio products and fine chemicals in a sustainable manner. It has been estimated that, every year photosynthesis alone accounts for conversion of 100 billion metric tons of CO2 and H2O to cellulose and other biomass products. Hence biomass driven industry is one of the fastest growing sector, their share on global economy is increasing about 5-20%. The total world annual biomass production is estimated at 2740 quadrillion BTU's. At present, only about 7% of the annual production of biomass is used.

However, for the sustainable utilization of biomass for bio products generation incredible metabolic diversity and biochemical conversion power of microbes need to be explored. With the microbes, it is possible to produce either several gaseous (hydrogen and methane) or a large variety of liquid biofuels and fine chemicals using biomass as a substrate. Apart from major cell wall degrading biocatalysts (cellulases, hemicellulases and ligninases) a new arena of enzymes are being explored for efficient conversion of plant biomass towards production of commodity chemicals. Lytic polysaccharide monooxygenases, a new class oxidative cellulases with higher catalytic functions are being tested. Similarly in the depolymerisation of xylan, xylanases, ferulyl oxidases and xylosidases are recently been excavated for their potential. Finally to depolymerise the most recalcitrant polymer in plant cell wall i.e lignin, ß-etherases are reported to have multifunctional depolymerizing and higher catalytic efficiencies over laccase, lignin peroxidase and manganese peroxidases. Biocatalysts with such wide diversity and novel catalytic property are the need of the hour for bio based economy. Finally, at the industrial level extremozymes are towering impact in reduction of enzymes cost and pinnacling conversion efficiencies. We can call the biomass industry is going to be at its peak and continuously growing towards sustainability.

An another means of effective biomass feed stock utilization in large-scale applications will evolve from innovative research aimed at the development and implementation of biorefineries – multi-step, multi-product facilities established for specific bio-sourced feed stocks. Development of novel routes to high-value aromatic chemicals and fine commodity

Chemicals will have wide applications in plastics manufacture, food industry and personal care industries. More importantly, converting surplus commodities to biofuels and/or bioproducts will create new jobs, increase commodity prices, increase farm income, improve the balance of trade, and reduce country's dependency on imported fuel and chemicals thereby pave the way for sustainable development of the nation. On the other hand Industrial biotechnology processes aim to be cost-competitive, eco-friendly , and self sustaining compared to their petrochemical equivalents. Common to all processes for the production of energy, commodity, added value or fine chemicals is that raw materials comprise the most significant cost fraction, particularly as operating efficiencies increase through practice and improving technologies. Specifically, bio-based ethanol as an alternative biofuel has emerged as the single largest biotechnology commodity and is a leading example of how systems biology tools have significantly enhanced metabolic engineering, inverse metabolic engineering, and protein engineering strategies. This enhancement stems from the method development for measurement, analysis and data integration of functional genomics, including the transcriptome, proteome, metabolome.

More importantly, algae for biofuels have been studied for many years for production of hydrogen, methane, vegetable oils (triglycerides, for biodiesel), hydrocarbons and ethanol.

The cultivation of microalgae for biofuels in general and oil production in particular is not yet a commercial reality and, outside some niche, holds significant applications in wastewater treatment, still requires relatively long-term R&D. In addition to biomass productivity and high oil content, one short-cut to the goal of algae biofuels development would be to co- produce algal biofuels, specifically, vegetable oils, with higher value products or in wastewater treatment. This pathway of development would allow this technology to develop and mature to the point where the algae biofuels could become an ever more important component of such processes, and eventually even the main outputs.

Eventually, the bioconversion platform should have the ability to serve as the basis for full- fledged biomass-based biorefining operations, generating value-added bio-products as well as fuel and energy. In addition, development of novel routes to high-value aromatic chemicals will have wide applications in the cyclic economy and a conceptual model of using biomass substrate for various derived products are outlined in Fig.1. More importantly, success in bio-based economy endeavour could provide a leap forward with respect to the low-cost conversion of renewable biomass into fuels as well as a variety of industrial chemicals with multiple applications, thereby realizing societal benefits.