Mixed Feedstock Approach to Lignocellulosic Ethanol Production—Prospects and Limitations

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Abstract Lignocellulosic ethanol is a promising alternative to fossil-derived fuels because lignocellulosic biomass is abundant, cheap and its use is environmentally friendly. However, the high costs of feedstock supply and the expensive processing requirements of lignocellulosic biomass hinder the development of the lignocellulosic biorefinery. Lignocellulosic ethanol production so far, has been based mainly on single feedstocks while the use of mixed feedstocks has been poorly explored. Previous studies from alternative applications of mixed lignocellulosic biomass (MLB) have shown that their use can bring about significant cost savings when compared to single feedstocks. Although laboratory-scale evaluations have demonstrated that mixed feedstocks give comparable or even higher ethanol yields compared to single feedstocks, more empirical studies are needed to establish the possibility of achieving significant cost savings in terms of pre-biorefinery logistics. In this review, some potential benefits of the use of MLB for ethanol production are highlighted. Some anticipated limitations of this approach have been identified and ways to surmount them have been suggested. The outlook for ethanol production from MLB is promising provided that revolutionary measures are taken to ensure the sustainability of the industry.

Keywords Bioethanol · Biofuel · Bioprocessing · Biorefinery · Mixed substrates · Lignocellulosic biomass

Introduction

Problems associated with the use of fossils as sources of fuels have positioned biofuels as viable alternatives. This is evident in the exponential increase in the consumption of biofuels in recent times [1]. Such problems include environmental concerns (global warming), depleting oil reserves, fluctuating oil prices and regional conflicts over resource control (e.g. Nigeria and South Sudan) [1–3]. The use of biofuels can overcome these problems as well as encouraging socio-economic development of rural communities [4]. Bioethanol is the most utilized non-fossil fuel for transportation globally. It can serve as an additive or substitute to gasoline and it is well-suited for automobile engines [4, 5]. Additionally, bioethanol has other varied uses which make it a highly valuable commodity. It can be used in domestic cooking as ethanol gels [6], in fuel cells [7], for hydrogen production and as a precursor for other chemical commodities [8].

Current commercial production of bioethanol is primarily based on sugar and starch crops (first-generation feedstock) [9]. The use of such feedstock is considered unsustainable due to competition with land and water, which are meant for food production; and unethical due to the controversial role in causing increase in food prices. Second-generation feedstocks in the form of lignocellulosic biomass are sustainable and fair alternatives because they are cheap, abundant and they do not exert undue pressure on land and food [10]. Lignocellulose is composed of cellulose and hemicellulose carbohydrate polymers which are held together by lignin. The sugar

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Published online: 17 June 2016