Fast-Growing Attention to Lignocellulosic-based Biomaterials in the Scientific Literature

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Technological advances based on biomaterials have attracted great attention worldwide. An attempt is made in this opinion piece to provide some data demonstrating recent trends in the publication numbers pertaining to lignocellulosic biomass and related topics.

Keywords: Biomaterials, Lignocellulosic biomass, Literature

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The use of starches and sugars obtained from herbaceous biomass, such as corn or sugarcane, as the raw material for manufacturing bio-products has led to a rise of food prices. Lignocellulosic feedstocks appear to be promising alternative sources of sugars that can be used to manufacture liquid fuels and other chemical products. Lignocellulosic biomass is the most abundant inedible biomass, with an annual output of around 10^{11} metric tons. The major and most abundant component of lignocellulosic biomass is cellulose, a chain of glucose molecules. Hydrogen bonds colligate layers of these chains and lead to a crystalline structure. Hemicellulose, the second most abundant component, is composed of various 5- and 6-carbon sugars including xylose, glucose, mannose, arabinose, and galactose. Lignin, which has quite different polymeric characteristics and structure, has three major phenolic compounds, namely p-coumaryl alcohol, coniferyl alcohol, and sinapyl alcohol as the basic building units. Cellulose, hemicellulose, and lignin form structures that are called microfibrils. The microfibrils are further organized into fibrils, which are responsible for the structural stability of the plant cell wall (Rubin 2008).

Common sources of lignocellulosic biomass include corn stover, switchgrass, sugarcane, and citrus peel. Conversion of lignocellulosic biomass into value-added products provides important environmental and economic benefits. Utilization of D-glucose, D-xylose, L-arabinose, and D-galacturonate, which come from the hemicellulose component of wood, is critical for the economic viability of lignocellulosic fermentation, as they constitute more than one-third of the sugars in lignocellulosic biomass. One of the most important future applications of lignocellulosic materials is as raw material in producing bio-ethanol. Although there has been significant progress in ethanol production, the relatively low market price of ethanol has led researchers to focus on the production of more valuable compounds, such as xylitol and biodiesel (Tai *et al.* 2016). A key point to use lignocellulosic materials as an energy source is the ability of bacteria and fungi to utilize lignocellulosic biomass from wastes and crops.

To further understand the importance of lignocellulosic materials, it is interesting to consider the obtained publication list using Scopus (date of search: Apr 06, 2017). The

number of publications containing the word "lignocellulose" as title is 4995. From Fig. 1A it is clear that has been a rapid growth since 2005, indicating that lignocellulosic materials have been extensively studied in various academic centers.

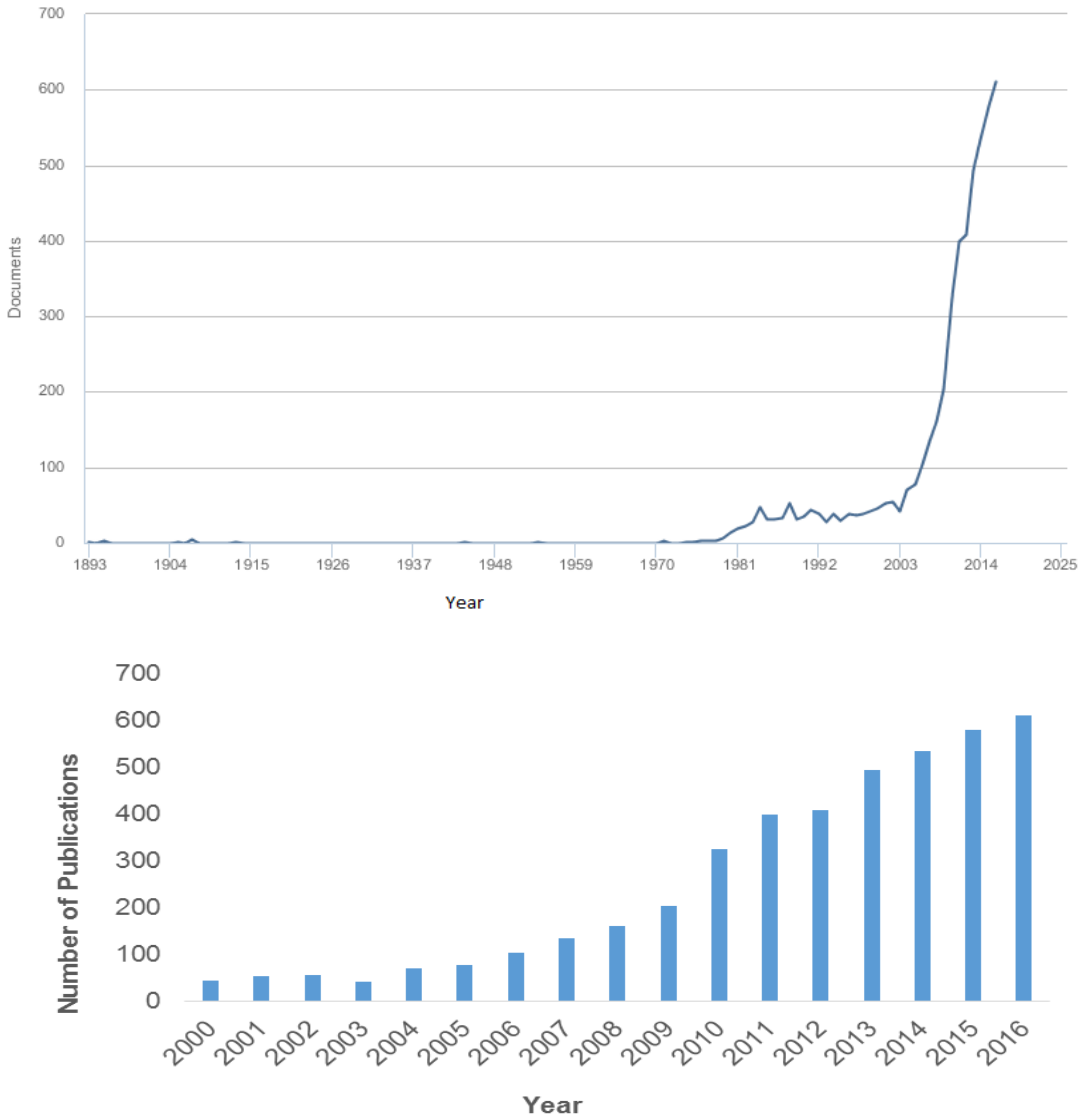
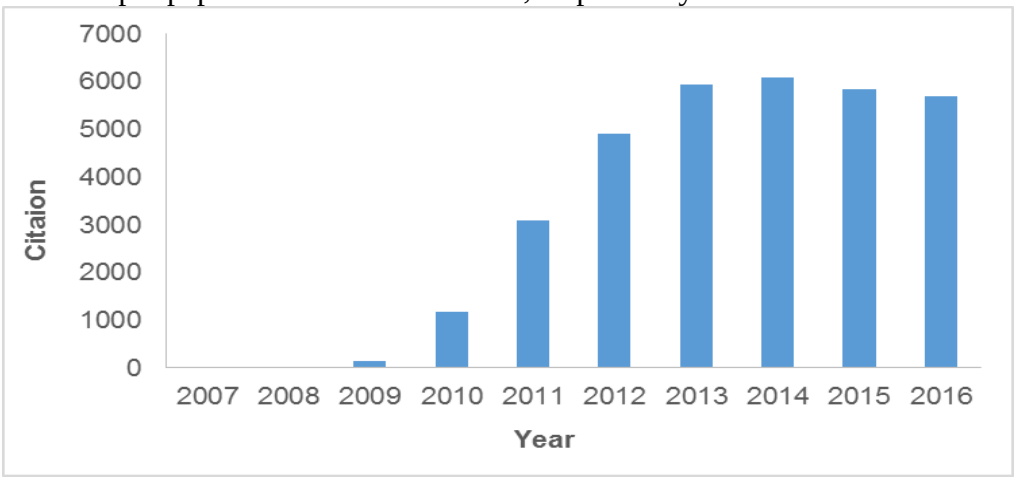


Fig. 1. A) Published articles from first article in 1893 to 2016, B) Greater detail from 2000 to 2016

This rapid growth began from 2005 with 78 publications and reached to 611 publications in 2016. As shown in Fig. 1B, almost 3150 papers about the lignocellulose-based materials have been published since 2009, which account for 67% (≈2/3) of total papers about lignocellulose shown in Fig. 1A. In particular, almost 24% (≈1/4) of papers concerning the versatile applications of lignocellulosic biomass were published in 2015 and 2016.

The dramatic increase of total annual citations is also shown in Figure 1.A. Surprisingly, the citation index of the publications concerned with lignocellulosic

materials exhibits an h-index of 137. The total citations and the average number of citations per paper are 122258 and 23.22, respectively.



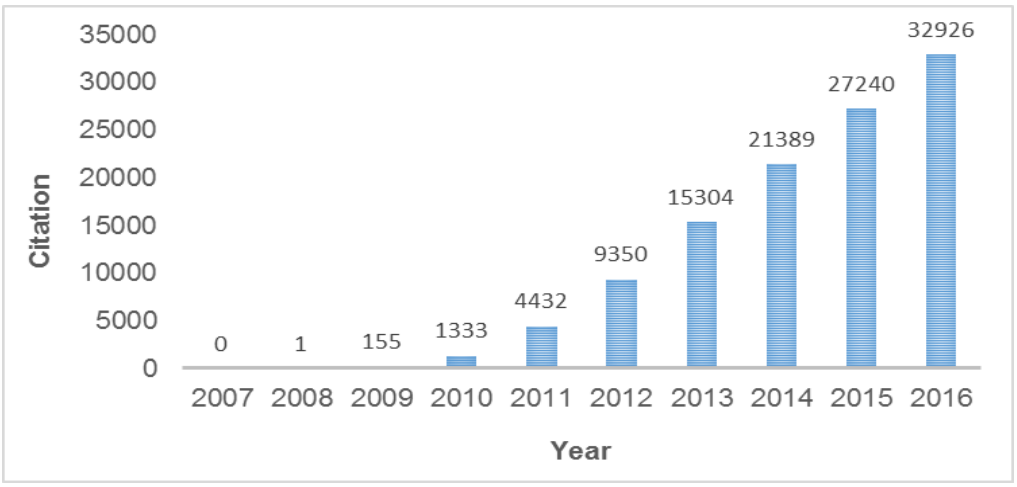


Fig. 2. A) Citations in each year from 2007 to 2016. B) Cumulative citations from 2007 to 2016

As shown in Fig. 2, citations pertaining to biomass research have likewise been growing rapidly. By analogy to fast-growth biomass species such as poplar, sugarcane, and switchgrass, the scientific field of lignocellulosic materials also has been growing at a fast pace.

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