

## New Perspectives on Bioethanol Production

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Bioethanol of first generation can be produced by the fermentation of plants containing sugar and starch. Whereas second generation bioethanol can be produced through hydrolysis and subsequent fermentation of cellulose [1]. Then, this second type do not compete directly with food crops for land use since it can be obtained from a wider range of feedstocks (agricultural residues, woody raw materials or energy crops) [2,3]. However, currently wheat is still the main crop for bioethanol production. Figure 1 shows global ethanol production by different countries from 2007 to 2015. It can be observed that the values peaked in 2015 after a dip in 2011 and 2012. Moreover, it indicates that the countries with the highest production and USA and Brazil.

The bioethanol production process depends on the feedstock, going from the simple conversion of sugars by fermentation, to the multi-stage conversion of lignocellulosic biomass into ethanol [4]. Moreover, some thermochemical processes have been analyzed to produce bio-ethanol: gasification followed either by fermentation [5], or by a catalyzed reaction [6].

The technology for cellulosic bioethanol production relies a pretreatment, chemical or enzymatic hydrolysis, fermentation and product separation or distillation. The main problem of this process is the pretreatment of raw material due to the complexity of lignocellulosic structure (cellulose, hemicellulose and lignin) [4]. Many researches have developed different physical, physical-chemical, chemical and biological processes for the pretreatment of lignocellulosic biomass [4]. However, there is no evidence about the best route in obtaining cellulosic bioethanol. Other problem related to cellulosic bioethanol production is the requirement of advanced technologies and facilities to aid the conversion process. For that reason, new raw materials have been investigated to produce bioethanol. One of them are marine organisms, such as algae.

Thus, the third generation bioethanol is focused on the use of algae as raw material. Algae can be considered as a suitable feedstock for bioethanol production due to the ease of cultivation and abundance [7]. The production of bioethanol from algae involves some previous steps before hydrolysis and fermentation which involve a drying process with the aim to preserve the crude extract and prevent the algae from gelling [8] and a size reduction to increase surface area.

In recent years there are numerous investigations [9] that have been made for the development of bioethanol production by fermentation of polysaccharides of macroalgae, especially from brown algae. However, the development of an efficient, advanced and significant

bioethanol production process from algae still requires a detailed study of optimization in the steps of hydrolysis and fermentation. Third bioethanol could be an attractive alternative for renewable energy. However, there are still some challenges hampering its production and consequent commercialization.

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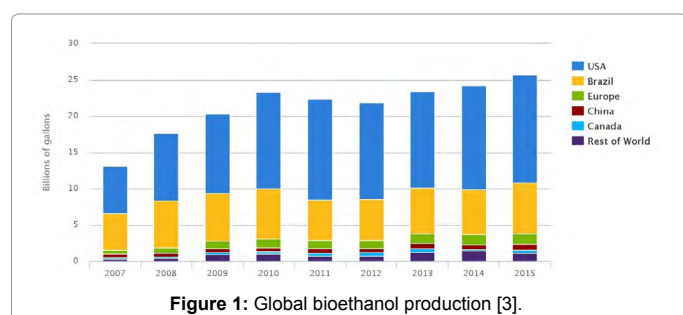


Figure 1: Global bioethanol production [3].

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Received October 03, 2016; Accepted October 10, 2016; Published October 12, 2016

Citation: Maceiras R (2016) New Perspectives on Bioethanol Production. Pharm Anal Chem Open Access 3: e108. doi:10.4172/2471-2698.1000e108

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