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ORIGINAL RESEARCH ARTICLE

THE POTENTIAL OF BIOETHANOL AS A VIABLE ALTERNATIVE TO FOSSIL FUELS

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ABSTRACT
Environmental challenges from fossil fuel emission have global issues and have contributed immensely to climate change. Bioethanol has experienced unprecedented level of attention due to its value as substitute to fossil fuel. Besides being a renewable and sustainable source of energy, it is also efficient, available and environmentally friendly. Global production of bioethanol continues to increase and will probably continue to dominate the alternative fuels market in the next decade. It is important to emphasize that for bioethanol to be a viable alternative, it must have ecological benefits, be economically competitive and its production must be in commercial scales without affecting the food production. This paper explains the problems and possible solutions in the production of bioethanol; since biofuel produces clean energy which can reduce the emission of CO_2 into the atmosphere.

1.0 Introduction

Environmental problems arising from fossil fuel emission have become global issues, for instance, greenhouse effect. According to Intergovernmental Panel on Climate Change (IPCC), fossil fuel contributes to approximately 75 percent increase in carbon-dioxide (CO_2) emission (Metz et al., 2005; Olajire, 2010). Over the last decades the world has begun to realize the significance of finding clean, sustainable and renewable forms of energy. One of these is first generation biofuel (bioethanol and biodiesel); bioethanol is obtained from the fermentation process of crops such as corn, cassava, rice, sugarcane, soya-beans, wheat, barley, and potato while biodiesel is produced by oil crops (rapeseed, soybeans, sunflower, palm, coconut) and animal fats. Second generation biofuels include bioethanol and biodiesel produced from the residual, non-food parts of crops, and from other forms of lignocellulosic biomass such as grasses, wood, and municipal solid wastes (Inderwildi and King, 2009; Gibbons and Hughes, 2011). Third generation biofuels include algae-derived fuels such as biodiesel from microalgae oil, bioethanol from microalgae and seaweeds, and hydrogen from green microalgae and microbes (Aylott, 2010; Dragone et al., 2010; Gibbons and Hughes, 2011). Also, fourth generation biofuels uses genetically modified (GM) algae to enhance biofuel production

Bioethanol is a good replacement to fossil fuel because it does not have the impurities such as sulphur oxides that are commonly found in petroleum products. Sulfur dioxide, emitting from fossil fuel is one of the important air pollutants leading to climate changes, acid precipitations, and health problems. Sulpfur dioxide can cause a serious health related problems such as asthma and chronic bronchitis. Besides, it can cause both acute and chronic injury to plants and affect their growth and production.

This review explains the problems and possible solutions in the production of bioethanol since biofuel produces clean energy which can reduce the emission of CO_2 into the atmosphere. Licht (2005) claimed that global production of bioethanol has increased rapidly since 1970 when there was oil crisis; its sales rose sharply from 1975 to 2006. The biofuels supply has increased globally by a factor of 8% from 2000 to 2010 (Figure 1). Goldemberg and Guardabassi (2009) explored that the present use of bioethanol as a fuel is around 86.4 million litres, accounting for 0.7% of the global oil production and 2% of the fossil fuel consumption, while utilizing less than 1% of the world's cultivating land. In 2006, about 45 billion litres of bioethanol were produced globally and more than half of this was generated in Brazil and the United States (Goldemberg and Guardabassi, 2009; Dufey, 2006). It is estimated that significant amount of bioethanol was produced globally to replace roughly 2 per cent of total gasoline consumption. Table 1 shows the main bioethanol producing countries.

Table 1: Global bioethanol production (Dufey, 2006)

Country	Production (ML)	Feedstock
Brazil	15,098	Sugarcane
US	12,907	Corn and sorghum
Canada	231	Wheat and straw
Colombia	900	Sugarcane
Germany	269	Rye, wheat
France	829	Wheat, beet
Italy	151	Wheat
Spain	299	Barley, wheat, wine
Sweden	98	Wheat, Forestry
UK	401	Beet
China	3,649	Corn, cassava, sugarcane
India	1,749	Sugarcane
Thailand	280	Sugarcane, cassava
Indonesia	167	Sugarcane
Pakistan	26	Sugarcane
Philippine	83	Sugarcane
South Africa	416	Sugarcane
Malawi	6	Sugarcane
Ghana	6	Sugarcane
Zimbabwe	6	Sugarcane
Kenya	3	Sugarcane
Australia	33	Sugarcane

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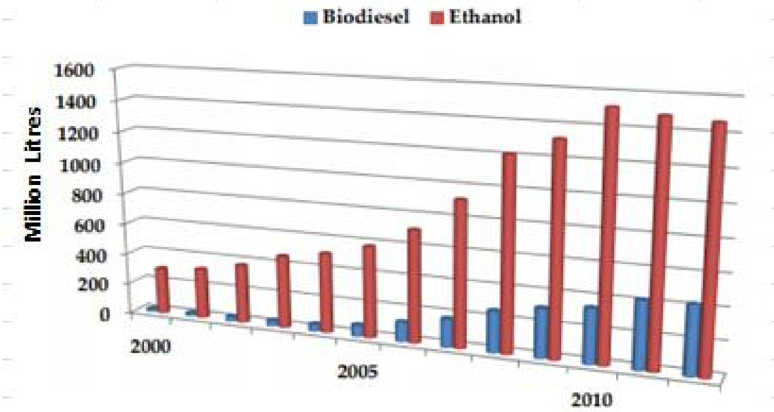

Figure 1: Worldwide biofuel production (Araujo et al., 2017)

2. Bio-ethanol and their challenges

2.1 The Food-Fuel Debate

One aspect of the challenges of bioethanol that has received much attention is the possible link between bioethanol production and food shortage (Figure 2). Increased bioethanol production will increase the cost of crops which are the major feed-stocks, and this will result to the rise in the price of food commodities. Fargione et al., (2008) claims that recent policy decisions to produce advanced biofuels on high standard farming land contributed to the food shortage. However, the problem of food shortage can be solved through improved farming techniques such as efficient use of fertilizers and pesticides that will boost crop yields.

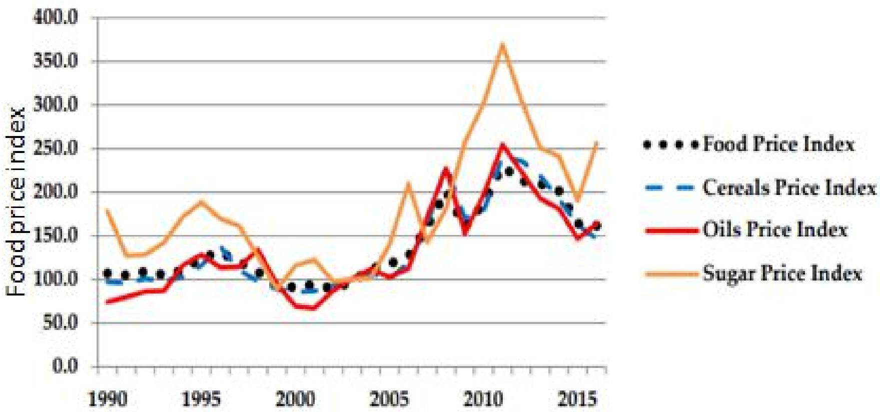

Figure 2: Food price index and key elements (The Food Price Index reflects the commodity group price indices (Araujo et al., 2017)

2.2 Technological Issues

Another problem that is affecting the bioethanol production is technological issues for example, conversion technology and biotechnology. Bioethanol production from cellulosic materials is having challenges of technology (Goldemberg and Guardabassi, 2009). Bothast (2005) says that about ten percent of corn crop generated 3.4 billion gallons of bioethanol fuel in 2004 and its demand was expected to be more than double in the next ten years. So, to meet this demand, new technologies must be moved from the research stage to profit-oriented level (Damirbas and Balat, 2006).

Therefore, global scale production of bioethanol requires high-technology (advanced technological development) and techniques such as modelling, simulation and optimization. This should perhaps be applied to some processes such as fermentation, distillation, cogeneration, residue treatment, recycling, instrumentation and automatic control systems and this will contribute to the vast growth of bioethanol production. For instance, sugar production through technological advancement contributed to significant increase in the production (Costa et al., 2010). Cardona and Sanchez (2007) suggested the usage of both ultrafiltration and microfiltration for the collection of the cellulose from the enzymatic hydrolysis reactor during the production of bioethanol from metropolis refuse. Cardona and Sanchez (2004, 2006) used Aspen Plus (software) to simulate several technological configurations that will improve the yield of bioethanol from biomass and certain processes and integration possibilities are to be taken into consideration (Cardona and Sanchez, 2007). A trial plant was constructed for the conversion of lignocelluloses biomass into bioethanol, operated for the purpose of research and development among associate industries that deal with biomass bioethanol technology (Cardona and Sanchea, 2007). Bai et al. (2008); Zhao and Bai (2009) noted that constructions of pilot and large factories have been built in China for the continuous bioethanol production using flocculent yeast strain for instance, bioethanol accumulation and recycling for many batches (Mussatto et al., 2010). Hence, advanced technology development could provide the means to develop economical technologies for the production of fuel bioethanol and consequently increase its production for global scale.

2.3 Government Policy

There are policy issues, for example, uncertain governmental policies such as un-supportive policies, and uncertainty in policies. Government policies that support demand and encourage the investment and research needed to develop an alternative fuel is paramount for environmental improvement and energy security. Government can enhance the production of bioethanol by introducing certain programs such as subsidies, research and development programs. The advancement of any nation is as a result of high level of research and development, for example, Sao Paulo in Brazil has made huge investments in genetic research and sugarcane improvement breeding (Hira and Oliveira, 2009). Balat and Balat (2009) says that the policy tools in China for bio-fuel promotions are tax, subsidies, cost limit, quotations, and establish changes by law (Balat and Balat, 2009). Gnansounou et al., (2005) also claims that two major bio-ethanol fuel programs have been accomplished in China from 2001 with the aim to enhance renewable energy sources, enhance public energy security and improve national territory (Balat and Balat, 2009).

Therefore, it is possible for bioethanol production to provide a viable alternative to fossil fuels on global scale, for example, private companies and public sectors are presently making progress on developing cellulose bioethanol industry (Keeney, 2009). Indian's Government gives 40 per cent subsidized loans for sugar factories who are interested in bioethanol manufacturing (Coyle, 2007). In addition, Thailand which is agricultural based nation is encouraging bioethanol production that is currently obtained from sugarcane and cassava (Mussatto et al., 2010; Dufey, 2006). Bioethanol production increased worldwide from 17.25 billion litres in 2000 to over 46 billion litres in 2007 and its demand will exceed 125 billion litres by 2020 with the new governmental programs of America, Europe and Asia (Balat and Balat, 2009). Governments justify support in order to achieve societal goals, for example, to diversify energy sources, to enhance energy security and to meet environmental and rural development objectives.

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3. Conclusion

Biothanol has experienced unseen levels of attention due to its value as substitute to fossil fuel and also mitigation option for climate change; besides being a renewable and sustainable source of energy, it is also efficient, available and environment friendly. Researches are presently focus on the development of concepts such as renewable resources and sustainable development. Hence, global production of bioethanol is increasing, and it will probably continue to dominate the alternative fuels market in the next decade. Biothanol as a viable alternative to fossil fuel requires a vital role from agriculture, technology, and government intervention such as research and development, subsidies and tax reduction. It is also important to emphasize that for bioethanol to be a viable alternative, it must have ecological benefits, be economically competitive and its production must be in commercial scales without affecting the food production. Bioethanol for use as fuel is better produced from biomass to prevent the scarcity of food supply. Biomasses such as cassava peels, corn cobs, mango peels, sawdust, sorghum straw, and rice husks which are readily available in Nigeria can serve as an alternative to food usage. Conversion of these biomasses to bioethanol can create wealth from such wastes.

The research into the sustainability of bioethanol production with respect to food versus fuel tradeoffs and land use are required. If sustainability and technical challenges are effectively worked out, these fuels have great potential to proffer solutions to the problem of climate change. During the process, there must be sustainability of global biofuel development by placing emphasis on the technical, policy and investment aspects. Researches that could promote the scale of substitution of biofuels in the global fuel markets are also encouraged in the future work.

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