INTERNATIONAL JOURNAL OF
PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

BIOFUEL: AN ATTEMPT TO COMBAT FUTURE FUEL DEMAND

B. MISRA, A. SAHA, S. CHOWDHURY

BCDA College of Pharmacy and Technology, 78 Jessore Road (S), Kolkata – 700127, India

Accepted Date: 13/10/2015; Published Date: 27/10/2015

Abstract: Biofuel is defined as any fuel whose energy is obtained by a biological process of carbon fixation. In other words, the process which can converts carbon dioxide into a molecule that can be found in a living organism is carbon fixation. Rapid depletion of fossil fuel, gradually increasing the demand for fuel in future, the due to the exhaust emission of the fossil fuel causing global warming and climate change, has led to search for finding the alternative solution regarding the energy has been put forward. The prime requirements for a biofuel the starting material must be CO_2, can also be made in a laboratory or industrial setting, through chemical reactions using organic matter. A forthcoming energy crisis will seize our social and economic growth if we do not change our usual practice and selection of energy source. Research has shown that internal combustion engines designed for petroleum fuels usage, which not suitable for long time operation on biofuel. Considering all the pros and cons and fuel properties this can be comprehended that multi-functional fuel additives may make biodiesels more engine compatible, but it will increases its price.

Keywords: Biofuel, Bio-mass, Carbon fixation

Corresponding Author: MS. S. CHOWDHURY

PAPER-QR CODE

Access Online On:

www.ijprbs.com

How to Cite This Article:

S. Chowdhury, IJPRBS, 2015; Volume 4(5): 288-299

INTRODUCTION

The basic definition of fuel is resource from which humans get energy. Fixation of carbon can produce a number of varied compounds, like proteins, fats, and alcohols etc. If any of these compound is used to produce energy in a mechanical setting, it can be called as a fuel. Now biofuel is defined as any fuel whose energy is obtained by a biological process of carbon fixation. Carbon fixation is the process of converting inorganic carbon into its organic form. In other words, the process which can converts carbon dioxide into a molecule that can be found in a living organism is carbon fixation. This process of carbon fixation occurring inside a living organism is called as 'biological carbon fixation'.

Again biofuel can be defined as any hydrocarbon fuel that is produced from organic matter (living or once living) over a short interval of time. This contrasts with fossil fuels, which are produce over millions of years and with other types of fuel that are not of hydrocarbons origin (nuclear fission, for instance).

Biofuels can also be made in a laboratory or industrial setting, through chemical reactions using organic matter (called biomass) to make fuel. The prime requirements for a biofuel the starting material must be carbon di oxide turned into another molecule by a living organism and the production time for final fuel product must be short and should not take millions of years.

Rapid depletion of fossil fuel, gradually increasing the demand for fuel in future, the due to the exhaust emission of the fossil fuel causing global warming and climate change, has led to search for finding the alternative solution regarding the energy has been put forward [1]. Biofuel is one of the most potential alternatives to cut down the dependency on fossil fuel by replacing it fully or partially, even though many alternative process have been discovered. Asian governments have following the suit have announced aggressive plans to increase biofuels production and its utilization. Some cases these plans have motivated the desire to reduce dependency on costly oil imports and also increase rural employment [2].

Presently, 98% of the entire demand of petroleum is used in transportation sector and it accounts for the emission of harmful CO_2, NO_2 and particular matters thus spreading global warming at an alarming rate. Reviewing report points out that of about 13.5% of the global warming is caused by the transportation sector [3].

Fossil fuels are widely popular for transportation and machinery energy source because of properties like high heating power, ease of availability and quality combustion characteristics, but high consumption is causing depletion of its reserve day by day. The diesel engine was invented and at the Paris Exposition in the year 1900 it was run by peanut oil [4].

Over the years, various organizations including United Nation have conducted several meeting and conference on global warming and climate changes which were attended by over 200 countries around the world [5]. Still, the consumption of fossil fuel by transportation sector is growing at a faster rate. Thereby, many countries have been giving priority in the development and implementation of sustainable energy in this sector, including Malaysia [6]. Malaysia is influencing biofuels production by a huge supply of palm oil and by 2011 is

intended to make biodiesel blends mandatory in its transportation sector to achieve carbon reduction towards sustainable development [7]. Malaysia is leading in the area of the production and export of palm oil.

Global energy status and transportation perspective

Fig. 1 projects the trend of the world energy production from 1990 to present and the projection until 2030. Alongside it an outline and consumption by transportation till 2050 is projected in Fig. 2 [8].

Above outline indicated that by 2030, altogether demand of transport fuel in the focus countries could rise by 15 percent to 350 percent based on the scenario. The lower-growth scenarios presume at the estimate of population growth, assumed to range from 0.6 percent (China and Vietnam) to 2 percent in the Philippines [9].

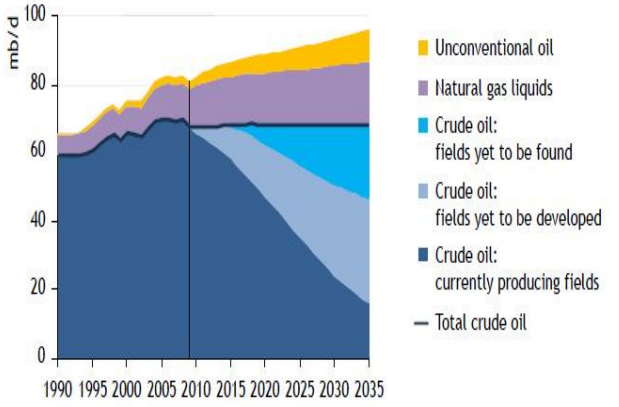

Fig. 1 The world oil production by type in the New

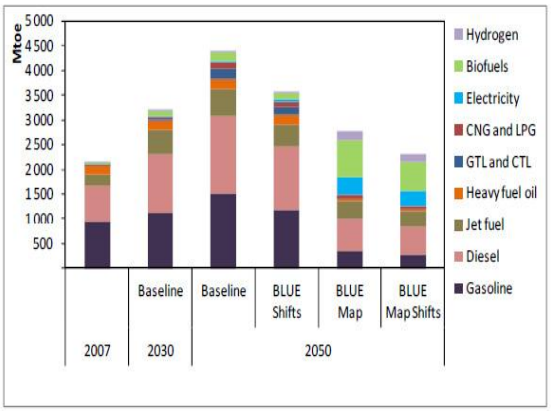

Fig. 2 The world Transport Energy Use by IEA/ETP Scenario

Biofuel

Biofuel is the eco-friendly and renewable source of substitute fuel, mostly processed from animal fats (poultry fats, lard, white or yellow grease, tallow or fish oils); recycled greases (used cooking and frying oils); and most frequently, plant oils (from soybeans, corn, rapeseed, sunflowers, and cottonseeds, etc.) [10].

Also this biofuel can be used in diesel engine without any engine modification [11]. Commonly, the word biofuel is applied for representation of all the liquid and gaseous transportation fuels that is mainly obtained from biomass [12]. Fig. 3 shows the biodiesel manufacturing process for diesel vehicle. Any biological carbon can be used to derive biofuels via different production procedures to produce source. Presently, biodiesel and bioethanol are the two most favourable biofuels being used to replace traditional fossil fuels in transportation. Biodiesel or fatty acid methyl ester (FAME) is normally synthesized by

Transesterification of vegetable oils with methanol and the support of suitable catalysts. Merchandising production of biodiesel has well flourished and is accessible in many countries to be purchased as turn-key [13].

On the other hand; bioethanol is suitable to replace the usage of gasoline in petrol engine. Fermentation of simple sugar or starch crops remains conventional method for bioethanol. Its large-scale production has been well successfully flourished in Brazil [14]. Intensive research for process optimization is still done at pilot plant scale to find a more cost effective production process for mass franchise [15].

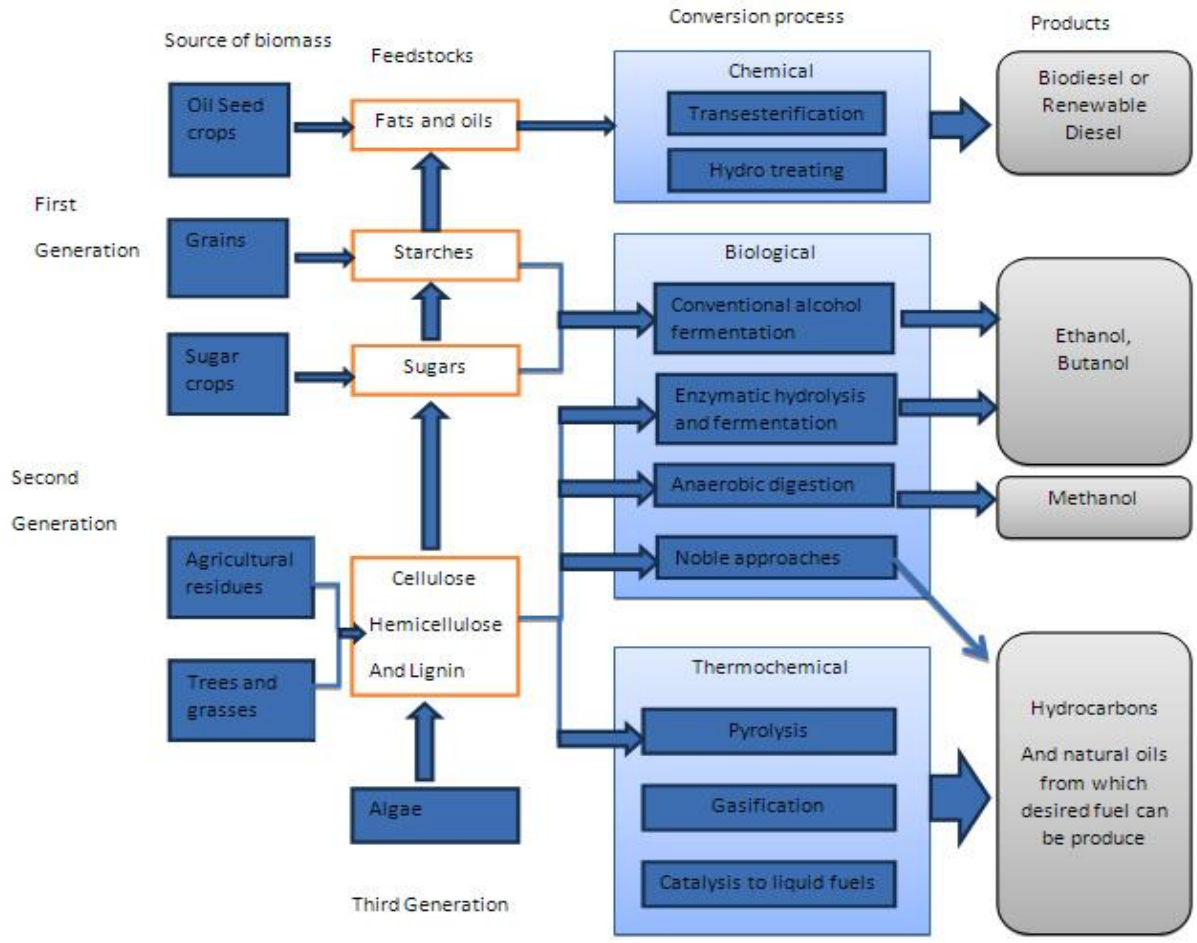

Fig. 3 Technological pathway to transform biomass into biofuel

Biomass

Biomass is basically organic matter. Kernels of corn, mats of algae, and stalks of sugar cane are some examples. Fossil fuels was a major factor in determining where energy came from before global warming related to burning, the major issue was that fossil fuels having limited in supply, would fall short over the next century. It was only then the thought of producing hydrocarbons another way came up, to meet energy demands. Thus one of the prime parting factors between a biofuel and a fossil fuel – renewability was spotted.

As fossil fuel takes millions of years to form it is not considered renewable. Biofuel, on the other side, derived from biomass that can be procured year after year through continuous farming practices. Thus proving biomass and biofuel are renewable.

'Renewable' energy and 'green' energy does not indicate the same meaning. Renewable energy is something that won't run out in centuries, like biofuels, hydroelectric, wind, and solar.

Whereas “green” energy is beneficial for the planet and does not have any negative effect. For example solar energy is a 'green' energy. All 'green' energy is reviewed as renewable, but not all renewable energy is green. Like Biofuels examples of renewable energy sources produce greenhouse gases thus aren’t considered green [16].

Types of Biofuel [17]

Biofuels, like fossil fuels, have numerous forms and serve as a number of various energy requirement. Biofuels is subdivided into two generations -

First Generation Biofuels

First generation biofuels are obtained from sugar, starch, or vegetable oil. The basic difference from “second generation biofuels” in that their feedstock (the plant or algal material from which they are generated) is not green or, have a large impact on the food supply if used in large quantity. First generation biofuels are the “original” biofuels and compose the majority of biofuels presently in use.

Second Generation Biofuels:

As second generation biofuels are made from sustainable feedstock are “greener”. Here, the word sustainable defines the feedstock availability and the effect of its use on greenhouse gas emissions, on biodiversity, and on land use (water, food supply, etc.). At this moment, most second generation fuels are under evolution and not convenient for use.

Biofuel Table

The following table separates biofuels down by generation and then discuss their uses, energy densities, and greenhouse gas impacts. Again for further exploration specific biofuels from the table are selected.

Fuel	Feedstock	Energy Density (mega joules/kilogram)
Bio-alcohol	Starches from wheat, corn, sugar cane, molasses, potatoes.	By Type
Ethanol		30
Propanol		34
Butanol		36.6
Biodiesel	Oils and fats including animal fats, vegetable oils, nut oils	37.8
Green Diesel	Made from hydrocracking oil and fat feedstock	48.1
Vegetable Oil	Unmodified or slightly modified	By Type
Castor Oil		39.5
Olive Oil		39
Sunflower Oil		40
Bio-ethers	Dehydration of alcohols	N/A
Biogas	Methane made from waste crop material through anaerobic digestion or bacteria	55

Table: 1st Generation

Fuel	Feedstock	Energy Density (mega joules/kilogram)
Algae - based biofuels	Multiple different fuels made from algae	Can be used to produce any of the fuels above, as well as jet fuel
Bio-hydrogen	Made from algae breaking down water.	Hydrogen compressed to 700 times atmospheric pressure has energy density of 123
Methanol	Inedible plant matter	19.7
Dimethyl furan	Made Â from fructose found in fruits and some vegetables	33.7

Table: 2nd Generation

Current Microbial Biofuels: Ethanol Produced by Fermentation

Production microbial biofuel is in use, mostly in the form of sugar fermentation by yeast to procure ethanol [22]. Although in ethanol production many microbes have been used, primarily

in industry the yeast species *Saccharomyces cerevisiae* is used, where the starting material for the process are starch and sugars from plants [23].

Fermentation of ethanol using *S. cerevisiae* is generally done by means of the standard glycolysis pathway [23]. The necessary simple sugars are formed via the hydrolysis of starch in the case of corn and other starch-containing plants, for yielding monosaccharide subunits, on other side the sugars in sugarcane requires hydrolyzing only once and then go directly into the pathway [25].

There are some advantages on use of fermented bio-ethanols as a fuel source over standard fossil fuels. An input of fossil fuel energy for both corn ethanol and sugarcane ethanol is required in order to produce them as of the energy requirements of farming, processing, and transportation. Although, several studies accounts that they provide more biofuel energy than fossil fuel energy that is put in them, proving a positive net energy balance (NEB), describing that they constitute more efficient energy sources.

Alternative Feedstock:

Lignocellulose

The bioethanol production solely utilizes the starchy or sugary elements of the agricultural crop, whereas much of the energy stored in the plant's biomass is wasted away. The unutilised parts of the plants, like stalks, leaves, and wood, are formed of lignocellulosic materials, and microbes find it difficult to break down. If these materials could be put to use, there would be representation of enormous new energy resource for producing biofuel [24]. Lignocellulose constitutes of different mixture of cellulose, hemicelluloses, and lignin, collectively they form a plant's cell walls providing structural assist to the organism. Cellulose is basically homo polysaccharide of glucose joined by β (1, 4) linkages between monomers. There is a β-linkage which is resistant to microbial degradation. Hemicellulose is a hetero polysaccharide, existing in wide variety comprising of numerous different sugars, xylose, arabinose, mannose, and galactose. Hemicellulose having composition so diverse, makes it difficult for many microbes to utilize such a wide extent of sugars. The end component of lignocelluloses, lignin, is a complex network of phenyl-propane units, not a polysaccharide. Lignin is intertwined across the plant's cellulose, giving structural support and further protection from microbes [27].

Fatty Acids and Glycerol

Microbes are incredibly diverse with respect to their ability to utilize different substrates, and this diversity provides the opportunity to use different compounds for making biofuels besides the standard carbohydrates. In particular, fatty acids provide one appealing alternative to sugars. Because they are so much more reduced than simple carbohydrates, fatty acids contain

much more carbon and energy with which to produce greater biofuel yields. Furthermore, because fatty acids are broken down directly into acetyl-CoA and do not have to go through the intermediate of pyruvate, they never have to be carboxylated, and thus unlike glycolysis, every carbon molecule from the substrate could theoretically be incorporated into the product. [25].

Using Efflux Pumps to Improve Biofuel Production

A common problem of biofuel production is that the biofuel itself is frequently toxic to the cell. This is the case with ethanol, the most common biofuel, and others. Furthermore, the accumulation of the biofuel within the organism itself often down regulates the pathway that produces it, decreasing production efficiency. The research group of Dunlop *et al.* sought to address this problem by engineering *E. coli*, introducing many different efflux pumps from different species of microbes to investigate whether or not the pumps would improve the organism's ability to survive biofuel stress, and determine whether it would improve biofuel production [26].

Use of Biofuels [18]

Ethanol and biodiesel are the two most common types of biofuels. Ethanol also called as ethyl alcohol, pure alcohol, or grain alcohol. The clear, colourless liquid is mostly discovered in alcoholic beverages produced by fermentation and distillation. Biodiesel is a liquid having colour ranging between golden and dark brown, depending on its origin. Primarily both ethanol and biodiesel are used for transportation. Motorized vehicles have internal combustion engines and are powered by the burning of a fuel (gasoline or diesel), inside a confined space called as combustion chamber within the engine. Biofuels being flammable, can also be used for internal combustion to power motorized vehicles. In other words, biofuels acts as a substitute for fossil fuels.

Advantages

Biofuel advocates frequently point out the advantages of these plant- and animal-based fuels, such as:

- Biofuels is remarkably inexpensive than gasoline and other fossil fuels.
- A wide range of materials including crop waste, manure, and other by products are used to manufacture biofuels making it an efficient step in recycling.
- Fossil fuels requires a very long time to be produced, but they are easily renewable with growing new crops and collection of waste material.

• Biofuels can be produced locally, decreasing the nation's reliance upon foreign energy .This help the country to protect the integrity of their energy resources and protect from outside impact.[19]

• As biofuels are produced locally, biofuel manufacturing plants can create employment for hundreds, making new scope in rural areas. Again Biofuel production encourages the demand for suitable biofuel crops, stimulating economic condition in the agriculture industry.

• Burning of biofuels, produce notably less carbon output and fewer toxins, thus it is a safer alternative preserving atmospheric quality.

Disadvantages

Despite the many positive characteristics of biofuels, there are also many disadvantages to these energy sources.

• Having a lower energy output than traditional fuels biofuel require greater quantities to be consumed so to produce equivalent energy level. [20]

• A high initial investment is often required for straining biofuels to more effective energy outputs and constructing the necessary manufacturing plants to extent the production limit.

• It could also raise prices of necessary staple food crops as biofuel production increases demand for food crops such as corn.

• For proper irrigation of biofuel crops huge amount of water [21] are required also for the manufacture the fuel, this could lead to straining of local and regional water resources.

CONCLUSION:

Current trends in energy consumption are neither secure nor sustainable- environmentally, economically or socially. A forthcoming energy crisis will seize our social and economic growth if we do not change our usual practice and selection of energy source. Severe shortage of petroleum fuels is projected as inevitable in near future coupled with a drastic Environmental implication. Hence, the hunt for an alternative clean fuel is vital. To date, wind, solar, tidal and fusion energy are all very prospective type of renewable energy. However, for a growing demand of transport fuel for millions of existing automobiles, we need an alternative that can easily adapt with the present supply and storing system and biofuel is such a candidate. Due to the fact that it is fungible to petrol and diesel in internal combustion engines with little modification.

Research has shown that internal combustion engines designed for petroleum fuels usage, which not suitable for long time operation on biofuel. Hence, a little modification can give a comprehensive solution in tailoring fuel properties for engine compatibility. And, Brazil has been the most successful nation in utilizing bioethanol with the introduction of its Flexi-fuel vehicles. On the contrary, to date, there is no modified vehicle patent that runs on biodiesel. Considering all the pros and cons and fuel properties this can be comprehended that multi-functional fuel additives may make biodiesels more engine compatible, but it will increases its price. So a mass production along with utilization needs a dedicated engine which could be done by modifying present day diesel engines on fuel supply system only.

REFERENCES

1. Mofijur M, Masjuki HH, Kalam MA Prospects of biodiesel from Jatropha in Malaysia. Renewable and Sustainable Energy Reviews 2012; 16:5007-20.
2. Kalam MA, Masjuki HH. Testing palm biodiesel and NPAA additives to control NOx and CO while improving efficiency in diesel engines. Biomass and Bioenergy 2008; 32:1116-22.
3. Baumert K, Herzog T, Jonathan P. Navigating the numbers greenhouse gas data and international climate policy. United States of America: World Resources Institute. In: 2005.
4. Ghobadian, B., Rahimi, H., Nikbakht, A.M., Najafi, G.,Yusaf, T.F., 2009.Diesel engine performance and exhaust emission analysis using waste cooking biodiesel fuel with an artificial neural network, Renewable Energy 34, 976-982.
5. UNFCCC. (United Nations Framework Convention on Climate Change). COP 16/CMP 6, Cancun, Mexico,http://unfccc.int/2860.php. In: 2010.
6. Ong H, Mahlia T, Masjuki H. A review on energy pattern and policy for transportation sector in Malaysia. Renewable and Sustainable Energy Reviews 2011;16:532-42
7. Lim S, Lee KT. Implementation of biofuels in Malaysian transportation sector towards sustainable development: A case study of international cooperation between Malaysia and Japan. Renewable and Sustainable Energy Reviews 2012; 16:1790-800.
8. Lew F. IEA transport projections to 2050: Moving towards sustainability? 2 September 2011, Kyoto, Japan.
9. US Bureau of the census 2008.
10. Shahabuddin M, Kalam M.A, Masjuki HH An experimental investigation into biodiesel stability by means of oxidation and property determination. Energy 2012; 44:616-22.
11. Mofijur M, H.H Masjuki, M.A Kalam, M. Shahabuddin. Experimental study of additive added palm biodiesel in a compression ignition engine. Energy Education Science and Technology Part A: Energy Science and Research 2012; 30:737-48.
12. Demirbas A. Progress and recent trends in biofuels. Progress in Energy and Combustion Science 2007; 33:1-18.

13. Lim S, LK. T. Recent trends, opportunities and challenges of biodiesel in Malaysia: an overview. Renewable and Sustainable Energy Reviews 2010; 14:938–54.
14. Pacini H, S. S. Consumer choice between ethanol and gasoline: Lessons from Brazil and Sweden. Energy Policy 2011; 39:6936–42.
15. López-Arenas T, Rathi P, Ramírez-Jiménez E, Sales-Cruz M. Acid pretreatment of lignocellulosic biomass: steady state and dynamic analysis. Paper presented at the Chemical Engineering Transactions 2010; 21:445–50.
16. De Gorter, H., and D. R. Just. The Social Costs and Benefits of Biofuels: The Intersection of Environmental, Energy and Agricultural Policy. Applied Economic Perspectives and Policy ; 2010; 32 (1): 4-32
17. Kalnes T, Marker T, Shonnard DR. Green diesel: a second generation biofuel. Int J Chem Reactor Eng 2007;5:748.
18. Demirbas MF. Current technologies for biomass conversion into chemicals and fuels. Energy Sour Part A 2006;28:1181–8
19. New Biofuels Market to Reduce Foreign Oil Dependence, Story Number: NNS110816-18, Release Date: 8/16/2011 5:18:00 PM, By Lisa Daniel, American Forces Press Service and Mass Communication Chief Samuel Shavers, Secretary of the Navy Public Affairs.
20. Cornell Chronicle, "Cornell ecologist's study finds that producing ethanol and biodiesel from corn and other crops is not worth the energy" By Susan S. Lang.
21. "Biofuel crops could drain developing world dry" by Charlotte de Fraiture, Date 10.05.07
22. Bai, F. W., Anderson, W. A., Moo-Young, M. “Ethanol fermentation technologies from sugar and starch feedstocks.” *Biotechnology Advances*. 2008. Volume 26(1). 89-105.
23. Balat, M., Balat, H. “Recent trends in global production and utilization of bio-ethanol fuel.” *Applied Energy*. 2009. Volume 86(11). 2273-2282.
24. Bokinsky, G., Peralta-Yahya, P. P., George, A., Holmes, B. M., Steen, E. J., Dietrich, J., Lee, T. S., Tullman-Ercek, D., Voigt, C. A., Simmons, B. A., Keasling, J. D. “Synthesis of three advanced biofuels from ionic liquid-pretreated switchgrass using engineered *Escherichia coli*.” *PNAS*. 2011. Volume 108(50). 19949-19954.
25. Clomburg, J. M., Gonzalez, R. “Biofuel production in *Escherichia coli*: the role of metabolic engineering and synthetic biology.” *Applied Microbiology and Biotechnology*. 2010. Volume 86. 419-434.
26. Dunlop, M. J., Dossani, Z. Y., Szmidt, H. L., Chu, H. C., Lee, T. S., Keasling, J. D., Hadi, M. Z., Mukhopadhyay, A. “Engineering microbial biofuel tolerance and export using efflux pumps.” *Molecular Systems Biology*. 2011. Volume 7. a. 487.
27. Jorgensen, H., Kristensen, J. B., Felby, C. “Enzymatic conversion of lignocellulose into fermentable sugars: challenges and opportunities.” *Biofuels Bioproductions and Biorefining*. 2007. Volume 1. 119-134.