LIGNOCELLULOSE BIO RESOURCES AND RENEWABLE ENERGY

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Abstract
This paper proposes a study on the availability of raw materials for biofuels. In general, the bio resources depend on the geographical location and varies from season to season. Given the availability and the reduced costs, currently, lignocellulose biomass is the most promising feedstock for the production of bioethanol fuel. But the commercial production of this biofuel is limited due to the conversion technologies, namely the bioethanol yield of the agricultural residues and other lignocelluloses. For the design of the bioethanol production process, the physical evaluation of raw material is necessary, but also by the proportion of sucrose, starch and lignocellulose. And this is necessary because it presents significant share in the costs of bioethanol. The bibliographic study and the interpretation of the statistical data concludes that there are many bio renewable resources, with repercussions in sustainability.

Keywords: *bioethanol, lignocellulose bio resources, renewable resources, sustainability*

Classification JEL: *O13, Q20, Q42*

Introduction

The upside incidence of extreme weather conditions with alternating periods of drought and intense rainfall events, accelerates the degradation of the lithosphere, particularly in areas where the soil is structurally vulnerable. Without commenting on the causes, as long as we know the importance of plant biodiversity, it is necessary to retain as much vegetation on the surface as possible. But the agricultural production, for example, except the perennial and multi-species, is seasonal and in the temperate zone it is achieved maximum two cultures per year (double or successive crop culture). So the probability of permanent grassy ground is small. As a result, soil vulnerability to natural environmental factors is high. In these circumstances, only vegetable residues (roots, stems fragments) can strengthen and protect the soil functions. These include the protection against water and wind erosion, retaining water, increasing or maintaining the organic matter in the soil as natural nutrition, increasing the biological activity and improving soil structure, with impact on the improvement of the crop yields. The latter occupies arable land and are classified either as botanical family, either by type of production pursued. Arable land category is used for annual or perennial crop in the field, where the structure prevails the cereals. Those are either cultivated in the fall (autumn cereals) or in the spring, sometimes as a successive crop. The agricultural and economic importance of the grain was amplified by diversifying the product, due to the requirements of the market. Thus, the destination of bioethanol is generated from non-renewable energy resources exhaustion and by the greenhouse effect amplifying the global warming. For these reasons, but also because most of the times straws and stalks oversize the dumpsites or hinder the work of establishing a new rotation culture, the controlled biodegradation is beneficial in all aspects: socio-economic and environmental. In this context, it is evident that there is great potential for agricultural biomass (lignocelluloses waste). Their use for energy services (liquid biofuels for transport) could contribute significantly to achieving rural development and reduce dependence on external resources but also to diversify the energy sources. The diversification of energy supply and reducing the dependence on fossil fuels used in the transport sector are part of the Kyoto Protocol.

1. Plant biodiversity productivity support

Environmentalists believe that the value of biodiversity is very high. And reasonably speaking, the air is vital, the climate provides a comfortable ambience, the water and the soil are basic to produce food (Bran, 2012a). The soil exploited by plant biodiversity is defined as the lithosphere part for permissive cultivation and increased food supplies. At the same time, it fulfill multiple functions:

- Due to the ability of crops to fix atmospheric CO_2 by photosynthesis, at the rhizosphere level, carbon is stored in soils;

- The soil is at the interference between the environment, water resources and geological systems, which, along with biodiversity (from macro to micro size) and time, has generated;
- It provides permanent and unconditional support for the development of human activities.

The interaction between soil, water and air defines the operation of a unique system that has as main objective the development of sustainable agriculture capable of reducing pollution and environmental degradation, to provide services and environmental goods, maintaining at the same time and not least, the capacity of production. As a result, the agriculture is responsible for the proper management of the soil resources.

In Romania, taking into account the contribution to GDP and active population, predominates the bio-producing economic sectors (agriculture, forestry and fisheries), followed by the manufacturing thereof (according to statistics NIS 2012).

The field vegetable group, with significant weight in Romanian agriculture - cereals - includes many species, officially represented by 61 varieties of common wheat, 7 varieties of wheat loud, 3 varieties of Sudan grass, 2 varieties of millet, 10 rice varieties, 40 varieties of barley,5 varieties of oats, 250 varieties of corn hybrids, a variety of rye, 10 sorghum varieties, 4 hybrids of sorghum x Sudan grass, 10 varieties of triticale (Bran, 2012b). As a result, this diversification justify extreme productions, which was amplified by the addressed technique and by the influence of natural factors. "The inadequate crop management leads to great difficulties regarding the yield level, with effects on economical results, which cannot ensure a satisfactory production process, as well as a decent life level" (Bran et al., 2008). Hence the oscillating production of biofuels from agro sources.

2. Crop production

The bio economy, due to its multidisciplinary, integrates the vegetable kingdom in the vegetable-based biotechnology industry, which converts biomass into products and energy, which is the sustainable economic foundation. So, in a biological knowledge-based economy, not only energy but also products derive from renewable resources. Among them, the prevailing globally cultivated are the cereals. Those have occupied several years in a row, about 700 million ha, with an average of 3.59 tones productive grains / ha (in 2016).

For Romania, the arable land in 2014 was 9,395,303 ha, of which cereals were cultivated on 5.46357 million ha, accounting for more than half of arable fields (58.15%). The total production of grains was 19,286,236 tons (2015) with an average of 3.53 t grain / ha.

The comparative analysis of cereal grain production has shown that the global average production exceeds with only 1.67% the Romanian production, which is so insignificant.

If the FAO and the International Grains Council forecast for 2015/16 was conducted, it means that the world cereal production had the following destination: 44% food, 35% feed, 6% obtained biofuels and 14% others.

According to those described above and to the population situation at 1st of January 2016, each of the 7,295,963,230 people in the world would have 15.23 kg of grains annually. Also, 6% of the cereal production had to obtain 34,772,751,000 liters of bioethanol, - 21,020.850,000 liters from beans (starchy substances) and 13,751,901,000 liters from lignocelluloses waste (Table 1).

The calculations were carried out based on the average primary production, the harvesting of the raw material moisture content. But Shaw and Wright (1921) determined the dry weight of the plant at approximately half the weight at harvest (corn plant - ready to shock: 40.21% dry matter). The results were taken into account by the authors mentioned determined dry substance corn (whole plant).

Table 1. The centralization of the universally productive grain values (grain and vegetative mass; bioethanol)

Specification	UM	Remarks
Grain production	total, mil. t	2526
d.c.	44% for population consumption, mil. t	1111.44
	6% for ethanol, mil. t	151.56
cultivated area	total, mil. ha	704.2
Average production of grains	t/ha	3.58
Biotanol / t grain cereals	l	345 (345 l ethanol / ton grains - average maize, rice, barley and wheat; Balat et al., 2008)
Biotanol / t strains	l	225.7 (la 1000 kg resulting cobs; Balat et al., 2008)

Bean report: straw or stalks	1:1, mil.t	60.93:60.93 (40.21% dry matter; Shaw and Wright, 1921)	
Total bioethanol from cereal grains, l	60.93 X 345	21,020.85	∑ = 34,772,751,000
Total bioethanol from straw + stalks, l	60.93 X 225.7	13,751.901	
Population number	loc.	7,295,963,230	
Grain production per head	kg/man*year	15.23	
Bioethanol production per inhabitant and year	l/ man*year	4.77	
Total production of bioethanol per cereals cultivated hectare (theoretical)	l	49.38	

Source: personal calculations by global and local statistics and specific literature

Compared to the presented calculations, as theoretical yields, there are variations +/- depending on: the biomass raw material composition (the table), the bioethanol obtaining method, the type and the size of the refinery reactor.

Table 2. Compositions of corn grain, corn cob, corn stover and poplar

Component and specification	The type of biomass			
	Grain	**Cob**	**Stover**	**Poplar**
Starch, %	71.7	-	-	-
Cellulose, %	2.4	42.0	36.0	40.3
Hemicellulose, %	5.5	33.0	26.0	22.0
Protein, %	10.3	-	5.0	-
Oil, %	4,3	-	-	-
Lignin, %	0.2	18.0	19.0	23.7
Ash, %	1.4	1.5	12.0	0.6
Others, %	4.2	5.5	2.0	13.4
Total, %	100.0	100.0	100.0	100.0
Ethanol yield (gal / ton)	135	128	105	106
Biomass dry weight, %	52	10	48	52

Source: America's energy future panel on alternative liquid transportation fuels

3. The bioethanol yield of the plant biodiversity

Biofuels are produced from all that which means vegetation, so renewable organisms as an alternative to fossil fuels. From the main production, mainly grains from the commented example, rich in starch is obtained more ethanol than from the secondary production (dry vegetative mass) but the production of grain is directed to human consumption. Therefore, the waste must ensure the maintenance and rhythm of the bioethanol production.

The final bioethanol yield (table) is determined by the maximum yield of sugar, which may be obtained from a particular type of biomass, and the yield of sugars is determined by starch, cellulose, hemicellulose, and the combined content of the biomass. The yield of ethanol can vary between 105 gal / t and 135g / t (dry weight) in the case where all stages of the culturing process takes place at 100% efficiency, i.e., and all the structural components were used for the production of ethanol. But the efficiency for grain maize can decrease to 50%. The yields of ethanol can be improved (Wyman et al., 2005) with the combination of advanced pretreatment and enzymes to improve the efficiency of conversion of cellulose.

The conversion of biomass into cellulose ethanol benefits are:
- Obtain additional income for farmers;
- Energy security and trade deficit;
- Reducing emissions of greenhouse gases;
- Disposal of solid waste;
- Air and water remediation.

The ethanol production is an example of how science, technology, agriculture and industry must work in harmony to transform an agricultural product into a fuel (figure 1).

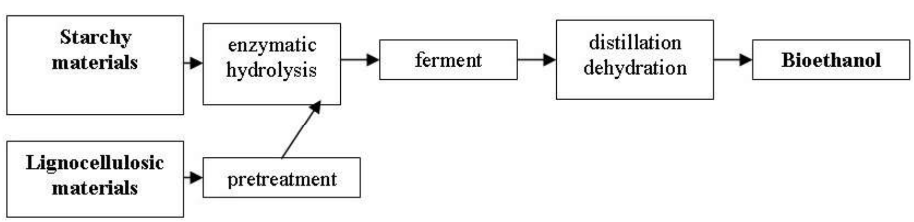

Figure 1. The technology of obtaining ethanol

Transforming biochemical cellulosic biomass into bioethanol (C_2H_5OH) involves several technological steps:
- Raw material preparation (washing, crushing)

- Weakening the structure of cellulose pretreatment and increasing porosity (e.g. hydrothermolysis or pretreatment with acids, alkalis, ammonia or other materials essential to improve ethanol yield and reduce production cost of ethanol);
- Saccharification: cellulose polymers are broken down by hydrolysis in sugars with five and six carbon (xylose and glucose) for fermentation into alcohol through enzymes;
- Fermentation: micro-organisms of yeast type (*Saccharomyces cerevisiae*) ferment glucose and xylose to ethanol. The reaction proceeds as follows: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Kcal. The released CO_2 is captured and can be used to produce carbonated soft drinks, or in greenhouses to stimulate plant growth;
- The distillation: the ethanol solution of the fermentation step is distilled to produce 95% ethanol;
- Drying: additional step to produce the required purity;
- Solid waste burning: the residual solids are rich in lignin and can be burned to generate electricity and heat needed in bio refining.

Integrating these steps with the involvement of microorganisms and enzymes is essential as it done the catalytic converters in bio refining, with repercussions for developing cost-effective processes.

The production cost for ethanol, specified in the literature (Kwiatkowski et al., 2006), is $ 0.27 / l (for an installation of 40 million gal / year ethanol fuel). The production costs for bioethanol made from wheat, for example in the EU-25, were 0.60 € / liter (Excluding taxes). Therefore, costs are variable as mentioned before.

Ethanol is a high octane fuel and, in combustion, produces low CO_2 emissions.

Conclusions

The importance of food grain orients producing biofuels technologies to renewable non-food raw materials.

As a result, it has been found that at an average production of 3.58 t / ha cereal, plant waste (straw and maize stalks) can produce 60.93 liters of bioethanol.

Developing biofuels industry must move toward the conversion of lignocelluloses materials (second generation biofuels), unused residues (agricultural or forestry), but potentially renewable.

The ethanol biofuel "rediscovery" was due to the need of an alternative to fossil fuels. The bioethanol production ensures the sustainable development and guarantees the future availability of fuel with low CO_2 emissions.

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