RESEARCHES ON USING SUGAR BEET FOR PRODUCING BIO-FUELS (BIO-ETHANOL AND BIO- GAS)

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Abstract: *The paper aims to make researches on the possibilities and advantages of producing bio-fuels , especially bio-ethanol and bio-gas obtained from sugar beet. One of the motives for this research is that a direction of European Union establishes that in 2020, 20 % of the energy consumption of Romania must be provided by rechargeable energy. In what concerns the researches stage, using of bio-fuels is a possibility more and more explored, both on international plan and in Romania, thus in 2007 in European Union existed 41 factories for producing bio-ethanol. Sugar beet wastes are estimated as 1.22 times sugar production, since the total dry matter of processing wastes and field wastes exceed the weight of sugar in the ratio of 55:45. Some or all of this may be used for fodder. With sugar beet yielding approximately 240 GJ/ha/y, 45% of it convertible to alcohol, 108 GJ/ha/y will be obtainable in the form of liquid fuel. The novelty of the present paper approach is the fact that sugar beet is less used for producing bio-fuel, although its energetic efficiency is bigger than that of some of much studied bio-fuels, such as bio-diesel. Other advantages presented by sugar beet as bio-fuel is the fact that the technology can be completely mechanized, the possibility of preserving it for long periods of time as syrup and a very good efficiency. In the paper there are presented researches over the comparative quantities of bio-ethanol and bio-gas obtained from wheat, potatoes and other materials compared to sugar beet. On the other hand, are presented the compared quantities of bio-gas obtained from different materials, from which resulted that sugar beet leafs have the best quantity of methane from bio-gas. We also proposed some business opportunities concerning the bio-ethanol and bio-gas obtained from sugar beet. The material used for researches is sugar beet, processed after a certain technology. The paper presents a big degree of practical applying and contains original researches.*

Key words: *sugar beet, bio-fuel, bio-gas*

INTRODUCTION

Sugar beet is a component of the specia *Beta Vulgaris L*. Mangels, developed from chard, are an important cattle food in Europe. From the mangel the sugar beet was developed. By selection, the sugar content has been raised from 5 to more than 20%. About one-third of the world's production of sugar is from sugar beets, the second most important source of sugar.

The decoction prepared from the seed is a folk remedy for tumors of the intestines. Seed, boiled in water, is said to cure genital tumors. The juice or other parts of the plant is said to help tumors, leukemia and other forms of cancer, e.g. cancer of the breast, esophagus, glands, head, intestines, leg, lip, lung, prostate, rectum, spleen, stomach, and uterus. A decoction is used as a purgative by those who suffer from hemorrhoids in South Africa. The juice has been applied to ulcers. Leaves and roots used as an emmenagogue. In the old days, beet juice was recommended for anemia and yellow jaundice, and, put into the nostrils to purge the head, clear ringing ears, and alleviate toothache. Beet juice in vinegar was said to rid the scalp of dandruff as scurf, and was recommended to prevent falling hair. Juice of the white beet was said to clear obstructions of the liver and spleen.

For fresh market, beets are harvested when 4–5 cm in diameter, and bunches 4–6; those 5–10 cm in diameter are sold as topped beets. Topped beets in transparent film bags have a longer shelf life than bunched beets with the tops attached. Most home and local beets are hand pulled, washed to remove adhering soil and variously marketed. Beets grown commercially for canning and frozen foods are harvested by a mechanical beet harvester, which lifts the beets, cuts off the tops, and conveys the topped beets to a truck alongside the harvester. The beets are then delivered to canneries, storage warehouses or to market. Beets more than 7.5 cm in diameter are in low demand, and they can only be used for diced beets or baby food products. Beets may be stored in cold, moist, root cellars for 3–5 months, at temperatures near the freezing point, but they should not be allowed to freeze. Humidity should be about 90%.

MATERIAL AND METHODS

The material used for experiments is sugar beet. Per 100 g, the leaf is reported to contain 45 calories, 86.4 g H_2O, 3.2 g protein, 0.4 g fat, 8.1 g total carbohydrate, 3.8 g fiber, 1.9 g ash, 114 mg Ca, 34 mg P, 3.1 mg Fe, 3152 μg β-carotene quivalent, 0.07 mg thiamine, 0.22 mg riboflavin, 0.6 mg niacin, and 50 mg ascorbic acid. English root analyses showed 76.6% water, 1.1% protein, 0.1% oil, 20.4 soluble carbohydrates, 1.1% fiber, and 0.7% ash. The pulp, after sugar extraction, contains ca 30% galacturonic acid in the form of pectic substances. This acid is a good starting base for vitamin C synthesis. Allantoin, saponins, copper, and betaine are also reported. Leaves contain quercitin glucoside, a vitexin combination with glucose, xylose, and 3-hydroxytyramine, β-sitosterol, and a suite of organic acids, oxalic-, tricarballyl-, aconitic-, ferulic-. Roots, herbage, and seeds contain raphanol, and coniferin ($C_{16}H_{22}O_8$), Vit. A, B, and C, and betaine. Roots contain a crude oil with palmitic-, oleic-, erucic-, and gamma-aminobutyric acids, free and bound invertase and pectolytic enzymes.

Sugar beet wastes are estimated as 1.22 times sugar production, since the total dry matter of processing wastes and field wastes exceed the weight of sugar in the ratio of 55:45. Some or all of this may be used for fodder. Due to lower insolation and crop growth, and more expensive and scarcer land, the prospects are for European alcohol to remain more expensive than that produced in the tropics. It may be of interest, however, to consider what area of good quality arable land would be needed to supply a certain quantity of energy, say 5% of estimated 1985 consumption in the Community, which is an amount calculated to make a major impact upon the overall supply of fuel for transportation purposes. This would amount to some 2,600 x 106 GJ/y. With sugar beet yielding approximately 240 GJ/ha/y, 45% of it convertible to alcohol, 108 GJ/ha/y will be obtainable in the form of liquid fuel. Hence, about 24 x 10^6 ha would be required, about thirteen times the area at present planted with sugar beet and 54% of the total arable area of the Community. Even then, all the required process energy, cultivation and fertilizer energy would have to be provided from other sources. To obtain these energy inputs from the sugar beet crop itself would demand a substantially greater area, depending upon the efficiency of cultivation and processing. The need might well encompass the entire arable area of the Community. In practice, therefore, it is difficult to visualise a situation in which more than 1% of the total Community energy demand could be met by sugar beet alcohol, since this would entail re-allocation of over 4.5 million hectares of good arable land even if there were very substantial inputs of other forms of fuel. In Europe, sugarbeet is likely to be preferred among non-cellulosic crops for alcohol production because the carbohydrate is in an immediately fermentable form. For Australia, irrigated sugarbeet yields were estimated at 50 MT/ha (8 MT sugar), Conversion rates were estimated at 130 MT commercial sugar, 45 MT molasses, and 63 MT dried beet pulp from 1000 MT beet. The beet pulp can be anaerobically

fermented to produce methanee as a source of energy for the distillery. Ca 75% of the energy in the pulp can be converted to methanee under mesophilic conditions with solids retention time of ca 8 days. The fodderbeet yields approached 50 barrels per hectare at a cost of less than $50.00 per barrel.

According to he EU directions, in 2020, 20 % from total energy will be obtained from rechargeable energy. That is why, there is a main concern for humans to look for alternative fuels, among which bio-fuels must be taken into consideration. In the last years, bio-fuels gained a special developments in the countries of EU. In Table 1 are presented the bio-ethanol productions in different countries of EU.

Table 1

The bioethanol productions in UE for years 2004-2008 and prospectives for 2010 in milions liters

Country	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Germany	25	165	431	397	578	2.396	2.396
Spain	254	303	396	348	334	578	1.090
France	101	144	293	1.030	2.151	2.151	2.151
Poland	48	64	161	119	176	730	730
Sueden	71	153	140	70	310	310	310
Italy	0	8	78	60	242	372	747
Hungary	0	35	34	30	335	1.409	1.409
Lithuany	0	8	18	19	29	144	261
Holland	14	8	15	12	12	836	836
Cechia	0	0	15	33	515	515	515
Letony	12	12	12	12	12	118	118
Finland	3	13	0	0	4	4	4
Belgium				0	733	823	883
Bulgary				0	40	40	40
Denmark				0	0	18	18
Estony				0	0	125	125
Ireland				2	15	15	15
Greece				0	0	0	350
Austrich				0	240	240	240
Romania				0	0	80	120
Sloveny				0	0	55	55
Slovacy				58	131	131	131
England				0	70	540	1.340
Total UE	528	913	1.592	2.190	5.927	11.630	13.884

Other advantages presented by sugar beet as bio-fuel is the fact that the technology can be completely mechanized, the possibility of preserving it for long periods of time as syrup and a very good efficiency.

The main products obtained from sugar bet are: sugar, bio-ethanol and bio-fuel. In table 2 are presented the surfaces cultivated with sugar beet and the production of sugar and bio-ethanol in EU in 2008.

In order to obtain bio-fuel from sugar beet can be used the following parts: sugar beet without and with leaves, draff and molasses. Sugar beet and its sub-products can be used as:

- mixted under-layer with 15 % sugar beet in instalations of 250-750 kw.
- single under-layer (100% sfeclă) in instalations > 750 kw

Table 2

The surfaces cultivated with sugar beet and the production of sugar and bio-ethanol in EU in 2008

Sugar beet	Surface ha	Total production of sugar beet tons	Medium production of sugar beet t/ha	Medium production of white sugar t/ha	Total production of sugar tons
Sugar beet	1.350.696	94.999.710	79,18	10,65	14.385.566
Sugar beet for bioetanol	133.721	10.588.028	79,18	7.910 l ethanol/ha	10.577.333.110 l ethanol

In the following rows, are presented a compared analysis of what can be obtained from 1 tone of sugar beet used for sugar and 1 tone of sugar beet used for bio-ethanol.

- 140-145 kg zahăr.
- 400 kg draff cu 14 % usefull substance used for animal food and bio-gas .
- 30 kg molasses used for chemical industry, bio-ethanol and bio-gas.

400 kg leaves used for animal food and bio-gas

The waste resulted from fermentation of drff and leaves can be used as fertilisers.

On the other hand, from 1 tone of sugar beet used for production of bio-ethanol can be obtained: 105 l bioetanol

400 kg draff used for animal food and bio-gas

400 kg leaves used for animal food and bio-gas

The waste resulted from fermentation of drff and leaves can be used as fertilisers.

RESULTS AND DISCUSSIONS

In the following table, are presented the compared quantities of bio-ethanol that can be obtained from 1 ha cultivated with sugar beet, wheat and potatoes. From this table, can be observed that the best results are obtained by sugar beet.

Table 3

The compared quantities of bio-ethanol that can be obtained from 1 ha cultivated with sugar beet, wheat and potatoes

Seed	**Production t/ha**	**Ethanol production (mc / ha)**
Wheat	7,2	276o
Potato	43,0	355o
Sugar beet	61,7	662o

From this table too, there can be observed that the best results are obtained with sugar beet.

Table 4

Quantities of bio-gas obtainable fro different basic amterials and the medium contain of methane (%)

Nr. crt.	Basic material	Obtainable bio-bas l/kg	Medium content of methane %	Contain of C %	Contain of N %	Report C /N
1	Wheat straws	250	78,5	46	0,53	87
2	Green grass	425	84,0	15	0,6	25
3	Spanish trefoil	460	77,7	48	2,6	18
4	Sugar beet leaves	450	84,8	41	1,0	41
5	Potatoes creeping stens	385	77,0	40	1,8	22
6	Corn strain	214	83,0	40	0,75	53
7	Pigs waste	445	60,0	7,8	0,65	13
8	Cattle waste	200	55,0	73	0,29	25
9	Birds waste	465	68,0	45	3,0	15

CONCLUSIONS

From all the aspects presented in this paper results that using of sugar beet in obtaining both bio-ethanol and bio-gas is very profitable, both from the point of view of the efficiency and the way of obtaing sugar beet.

We present some **bussiness oportunities with bio-ethanol from sugar beet**.

100.000 ha cultivated with sugar beet x 60 t / ha = 6.000.000 t sugar beet / year.

6.000.000 t sugar beet x 105 l bioethanol / t sugar beet =cca. 630.000 t ethanol / year.

Subproducts:

2.500.000 t draff .

2.500.000 t leaves.

Romania uses aprox. 4.000.000 t gasolene / year.

From 01.07.2009 we can use gasolene with 4 % bioethanol.

- Necessary 160.000 t bio ethanol/year
- Available for export: 470.000 t bio ethanol/year

Bussiness oportunities with bio-gas from sugar beet:

2.500.000 tons draff x 31mc bio-gas/t = 77.500.000 mc bio-gas/year

2.500.000 tone frunze-colete x 31mc biogaz/ t = 77.500.000 mc bio-gas// year

Total = 151.000.000 mc bio-gas/ year **or:**

2.500.000 tons draff x 108 kw/h /tons =270.000.000 kw/ year

2.500.000 tons leaves x 108 kw/h /tone =270.000.000 kw/ year

Total 540.000.000 kw/h/ year .

As we can see from these figures, the obtained quantities of bio ethanol and bio-gas from sugar beet are important, that is why the production of sugar beet for obtaining alternative fuels is very efficient and is worth taken into consideration.

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