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# MODERN DIRECTIONS OF SCIENTIFIC RESEARCH DEVELOPMENT

PROCEEDINGS OF VIII INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE
JANUARY 26-28, 2022

CHICAGO
2022

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Proceedings of VIII International Scientific and Practical Conference

Chicago, USA

26-28 January 2022

**Chicago, USA**

**2022**

# TOPINAMBUR ENERGY CULTURE FOR RENEWABLE ENERGY PRODUCTION

**Iesipov Oleksandr**
Candidate of Technical Science
Associate professor
**Polyashenko Sergey**
Candidate of Technical Science
Associate professor
State Biotechnological University
Moskovskii avenue 45, Kharkiv, Ukraine

**Abstract:** one of the most promising, alternative and renewable energy sources today is solid biomass (biofuel) of organic origin, including vegetable, which is an environmentally friendly renewable energy source.

One of the strategic directions of Ukraine's development is bioenergy. A lot of attention is paid to the renewable energy sector. The country's dependence on imported energy is primarily a basis for considering the great potential of biomass available for energy production.

Much work has been done in recent decades to improve the conversion of biomass to fuel. However, first-generation biofuels (bioethanol and biodiesel derived from food crops) are extracted from only a few crops with different efficiencies to convert solar radiation into chemical energy (biomass).

In particular, biofuel raw materials are mainly rapeseed, oil palms and soybeans - for biodiesel; and sugar cane, corn, sugar beets and sweet sorghum for bioethanol.

In addition, not all biomass is suitable for collection (ie underground biomass usually remains in the soil), so the net carbon trap decreases and processing inefficiencies increase. For these reasons, plant species for next-generation biofuel production are expected to overcome some of these limitations, especially if they have productive underground biomass (ie roots or roots).

In terms of biological productivity and yield of bioethanol per unit area,

Jerusalem artichoke is not inferior to other crops, in particular those that are key in food production.

Topinambur as a perennial high-yielding crop is characterized by high cost recovery, in particular for fertilizers.

**Formulation of the problem.** Recently, issues related to the prospects of using alternative energy sources have been gaining more and more attention from the world community.

Much attention is paid to the study of fast-growing energy plants, which should be grown for organic biomass. Such crops include fast-growing trees, various species of willow and poplar, annual and perennial herbaceous plants such as sorghum, sugar cane, miscanthus, amaranth, bitter gourd, Sakhalin mountaineer, Pennsylvania mallow, rumex, Topinambur, millet vine, hybrids [1].

**Presenting main material.** Research is currently underway on new biofuel energy production systems with less environmental impact, higher productivity and greater return on investment, as well as reduced competition for land use with food and feed crops.

For these reasons, plant species for next-generation biofuel production systems are expected to overcome some of these limitations, especially if they have productive underground biomass (ie roots or tubers).

Lignocellulosic biomass from isolated bioenergy crops and agricultural waste is considered a sustainable resource for bioenergy production, but hydrolysis using cellulolytic enzymes is a more time-consuming and expensive method than using biomass based on starch or molasses.

Currently, worldwide, sugar cane, corn grain, cereals, sugar beets and other energy crops are mainly used as raw materials for fuel bioethanol. The choice for growing energy crops takes into account the yield of this crop, the yield of bioethanol from 1 ha of cultivated area, the cost of seeds directly for growing, harvesting and storage, as well as the possibility of using waste remaining after production of fuel bioethanol for other purposes (eg animal feed). Table 1 provides information on the yield of bioethanol from 1 hectare of different crops.

**Table 1**

**Bioethanol yield from 1 ha of agricultural land area.**

| Energy crop | Average yield, c / ha | Bioethanol yield from 1 ha, l |
|---|---|---|
| Wheat | 20 | 600 |
| Corn | 48 | 1200 |
| Potato | 120 | 960 |
| Sugar beet | 450 | 4050 |
| Sorghum | 250 | 2000 |
| Cane | 560 | 4500 |
| Topinambur:<br>Root crops<br>Stems | <br>400<br>500 | <br>4000<br>2500 |

We believe that Topinambur, which is a multi-purpose crop and has a number of economic benefits, including a high yield of raw materials per unit area for bioethanol production, may be a partial alternative to growing corn for grain to produce bioethanol [2].

Topinambur is similar to sunflower, especially in the aboveground part. Jerusalem artichokes are often called pears, walnuts or Volga turnips. The leaves have petioles with jagged edges, color varies from green to dark green. The stem is covered with short hairy hairs and grows to a height of 4 meters. Topinambur inflorescence - a small basket with bright yellow flowers (Figure 1).

Topinambur has a well-developed root system that penetrates deep into the soil. In the bush at the ends of the underground shoots-stolons formed from 20 to 30 tubers weighing up to 120 g.

Homeland Topinambur is Brazil. The name of the plant comes from the tribe of Brazilian topinamba Indians. Jerusalem artichoke came to Europe in the early XVII century, where it quickly spread as a vegetable, fodder and industrial crop. Jerusalem artichoke came to Ukraine through the Balkans and Moldova. At first it was grown as a medicinal plant, then as a vegetable. Currently, they began to be used as an energy crop [3].

**Figure 1 - Jerusalem artichoke**

The most productive of perennial crops are giant miscanthus, sylph perforated, Weirich and Sakhalin bitters, perennial sedge, Topinambur and annual sunflower.

Topinambur is a highly productive crop, not picky about growing conditions, which responds well to the use of fertilizers. Given the low level of supply of mineral nutrients, which can be observed on unproductive lands, it is advisable to develop a system of fertilizers that could meet the nutrient needs of crops and have little effect on the cost of biomaterials. Topinambur as an energy crop can serve as a partial alternative to corn, which is grown for grain for bioenergy purposes, to replace the raw material base for bioethanol production [4].

Topinambur can be successfully grown on lands with low levels of soil bioproductivity, including degraded, agronomically transformed, disturbed and marginal soils. In the period from December to May in natural conditions with the help of frost and wind dried on the stump of Jerusalem artichoke stem to a humidity of 10-20%. This saves the producer 10-15 euros on drying one ton of raw biomass. Humidity of crushed raw materials for the production of solid fuels (pellets, briquettes) should not exceed 10-12%. Only dry raw materials have energy value (table 2).

**Table 2**

**Energy productivity, biometric indicators, thermal energy content of Topinambur**

| | |
|---|---|
| Energy productivity: | |
| Dry mass, t / ha | 11,8 |
| Thermal energy, GJ / ha | 207 |
| Conditional fuel, t / ha | 6,5 |
| Biometric indicators: | |
| Height, cm | 228 |
| Stem diameter, mm | 12,6 |
| Weight of 1 $m^3$ of dry cuttings from stalks, kg | 144 |
| The content of thermal energy in the dry chaff: | |
| MJ / kg | 17,8 |
| GJ / kg | 2,56 |

One hectare produces 10 tons of fuel pellets, the energy value of which is up to 7 thousand $m^3$ of gas.

Wood from energy poplar, willow and paulownia is harvested after 3-4 years of cultivation. Biomass from miscanthus is collected in the 3rd year of growth, while the stem of Topinambur grows in 1 year.

**Figure 2 - Finished semi-finished product from Jerusalem artichoke tubers and finished granules from dried Topinambur stalks**

The forage harvester selects, grinds dry stalks of Topinambur. After that, load the raw material into the trailer. The tractor transports it to a local consumer warehouse for incineration or to a plant for the production of pellets or briquettes.

The advantage of Topinambur is that you can quickly make a profit in the manufacture of biofuels, because its stem grows in just 1 year. This plant is suitable for growing in monoculture (gives good results when growing for 30 years in one

area), undemanding to soils, drought-resistant, and does not require high costs for the production of fuel pellets [5].

The cost of production of pellets from dried Topinambur stalks is 15-20 euros per 1 ton, from wood waste - 40-45 euros per 1 ton.

The buyers of pellets are industrial enterprises, greenhouse producers (this helps to reduce the cost of growing vegetables in winter and spring). Ukrainian biofuels are partially exported to Lebanon, Poland and Germany.

Also, high-density briquettes with high resistance to moisture are made from crushed dried Topinambur stalks, which are sold to people for heating houses.

Topinambur granules are used not only for heating systems, they are a good litter for animals and birds. Some poultry farms already use pellets as eco-litter. Topinambur granules absorb moisture well and swell. Used litter is a high-quality organic fertilizer, because in Topinambur the acidity of the stem is neutral, and in wood - high. Litter from Topinambur granules decomposes faster and better in the soil compared to litter from wood waste.

**Conclusions.** Growing Topinambur can be an effective tool in addressing public concerns about the conversion of food into fuel and rising food prices. Another aspect of solving the problem of competition between food and bioenergy production is that Topinambur, unlike cereals, can be successfully grown on unproductive lands, which are increasingly seen as an important reserve for expanding the area under energy crops.

The use of fertilizers for Topinambur, despite some reduction in the share of dry matter in the crop, provides significant increases in yield and increase the yield of dry matter per unit area. The effect and aftereffect of fertilizers is observed even four years after application on degraded soils. However, in Topinambur fertilizer systems, the repetition of agro-technological measures related to fertilizer application should be correctly calculated. This allows to significantly increase the productivity of agrophytocenoses and biomass yield per unit area.

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