THE IBASU-A COLLECTION OF ALGAL STRAINS AS BIORESOURCES FOR BIODIESEL PRODUCTION

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The growth characteristics and productivity of strains from the Microalgal Culture Collection (IBASU-A) were analyzed and some perspective high biomass producers were selected in the separated culture collection which considered as potential bioresource of feedstock for biodiesel production.
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Introduction

Increasing volumes of the fossil oil and gas utilization in 20th century has led to the problem of searching for alternative sources of energy and fuel which would be renewable and environmentally-friendly. Therefore, the active scientific researches on generation and usage of biofuel particularly biodiesel as the most needed and perspective energy source are carried out worldwide. Animal fats, agriculture oil crops and lipids from bacteria, yeasts, fungi and microalgae are used in the capacity of the vegetable raw material. The benefits of microalgae as producers are a high content of lipids, significant growth rate, possibility of controlled biosynthesis, great growth under different conditions – fresh, brackish, sea water, and even wastewater from plants and city sewages etc. (Chisti, 2007; Chernova et al., 2008; Feofilova et al., 2008; Sorochinsky et al., 2010; Gong, Jiang,2011). Also there intensive global researcher effots aimed at increasing the accumulation of lipids and carbohydrate production in different algal species by genetic engineering methods (Radokovits et al., 2010; Korkhovoy, Blume, 2013). Nevertheless, only around 30 species out of 45,000 microalgae known to date for the World flora are capable to accumulate higher quantity of lipids in dry mass (20-50%). These are the members of Bacillariophyta, Chlorophyta (flagellates and coccoid), Haptophyta, Eustigmatophyta, Euglenophyta, Rhodophyta and Streptophyta. An availability of lipid-producer strains in algal culture collections as well as a study on their capacity to active growth under cultural conditions is the significant element of investigation of these taxa (Perspectives …, 2009; Barbosa, Wiffels, 2013; Borowitzka, 2013). Some aspects of application of the microalgae from IBASU-A collection in biotechnology have been previouslydiscussed (Borisova, Tsarenko, 2004; Tsarenko et al., 2011, 2012).

The aim of this paper is to carry out screening of IBASU-A collection to find some species-producers of biomass and lipids for forming the single collection including the most perspective strains.

Material and methods

The screening has been conducted on the basis of the Microalgae Culture Collection of M.G. Kholodny Institute of Botany, NAS of Ukraine (IBASU-A), which contains more then 500 strains of 86 halophilic and freshwater algal species (Borysova, Tsarenko, 2004). According to original and literature data themaincriteriaforselectionwereanabilityof algae toaccumulatelargequantityoflipids, highbiomassproductivity, stresstoleranceandresistance to differentbiologicalcontamination. To select the productive strains at first the express-method including an algal cultivation under uniform culture condition with temper visual determination was used (Algae…, 2005). Then study of growth characteristics of the selected strains were carried out under intensive condition during 10 days at temperature 26-32°C, constant light intensity of 100 $\mu molm^{-2}s^{-1}$ and constant aeration. Initial cell density in the flasks was $5 \cdot 10^6$ cells ml^{-1}. The daily increase of algal biomass was estimated by microscopic counting cell concentration or determining cell dry weight concentration gravimetrically (Methods…, 1975). Such kinetic characteristics of algal growth as specific growth rate (μ) and productivity (P) were determined on the basis of obtained measures (Trenkenshu, 2005).

Results and discussion

In the results of conducted screening a new collection of the perspective high biomass producers has been formed. It includes 33 strains of 18 species from genera *Acutodesmus*(E. Hegew.) P. Tsarenko (6), *Botryococcus* Kütz.(1), *Chlorella* Beij. (6), *Chloroidium* Nadson (2), *Desmodesmus* (Chodat) Anetal. (7), *Enallax* Pascher(1), *Euglena* Ehrenb. (2), *Monoraphidium* Komárk.-Legner. (2), *Parachlorella* Krienitzetal. (6) and *Haematococcus* C. Agardh emend. Flot. (2).

The comparative investigations of growth and kinetic characteristics of 33 strains, namely: *Botryococcus braunii* Kütz.IBASU-A 504, *Chlorella vulgaris* Beij.IBASU-A 189, 190, 192, *Chloroidium saccharophilum* (W. Krüger) Darienko et al. IBASU-A 186, 187, *Parachlorella kessleri* (Fott et Novák.) Krienitz et al. IBASU-A 198, 199, 201, 444, *Acutodesmus dimorphus* (Turpin) P. Tsarenko IBASU-A 251, 252, *A. obliquus*(Turpin) P. Tsarenko IBASU-A 292, 473, *Desmodesmus armatus*(Chodat) E. Hegew.IBASU-A 270, *D. communis var. rectangularis* (G.S. West) E. Hegew. IBASU-A 371, *D. magnus* (Meyen) P. Tsarenko IBASU-A 401, 402, *D. multivariabilis* var. *turskensis* P. Tsarenko et E. Hegew. IBASU-A 398, *D. subspicatus* (Chodat) E. Hegew.IBASU-A 310, 407, revealed that they demonstrated rather active growth, high specific growth rate (μ) and productivity (P). Also the most of selected strains were characterized by short term of lag phase and had a shot adaptive period (1-2 days) as well as the highest speed during active growth. In the cultures of the highest productive strains from genera *Chlorella*, *Chloroidium*, *Parachlorella* the maximal cell concentration (B) reached 38–250 10^6 cells ml^{-1}. At the same time the specific growth rate and productivity were equaled 0.55–1.4 $day^{-1}$and 9.5–72.5$\cdot 10^6$ cells ml^{-1}per day,respectively. In the *Acutodesmus*, *Enalax*

and *Desmodesmus* culturesthe maximal cellconcentration were a little lower and reached 26–84.5·10^6 cells ml^{-1}, with thespecific growth rate and productivityequaled 0.35–1.2 $day^{-1}$and 6.4–29·10^6 cells ml^{-1}per day, respectively. At the same time a growth of algal biomass in the *Chlorella*, *Chloroidium* and *Parachlorella* cultures variedintherange of 0.51 g·$L^{-1}$to 1.6 g·L^{-1}dry weight per day and in the *Acutodesmus*, *Enalax* and *Desmodesmus* cultures did in the range of 0.34 g·$L^{-1}$to 1.6 g·L^{-1}dry weight per day.

The most productive strains under study were *A. dimorphus* IBASU-A 251, *D.magnus* IBASU-A 401, *Parachlorella kessleri* IBASU-A 444 и *Ch. vulgaris* IBASU-A 189 withincreasingbiomassintherangeof 0.9g·L^{-1} to 1.6 g·L^{-1}dryweightperday. The least productive strains under study were *Monoraphidium griffîtii* (Berkeley) Komárk.-Legner.IBASU-A 364, *Monoraphidium sp*. IBASU-A166, *Euglena gracilis* KlebsIBASU-A 496 and *Euglena sp.* IBASU-A 498 withincreasingbiomassintherangeof 0.27g·L^{-1} to0.38 g·L^{-1}dryweightperday.

It should be noted that the majority of above-listed species and strains are widely used in fundamental and applied researches and different branches of national economy, food and pharmaceutical industry. Forexample, *A. dimorphus* IBASU-A252, *A. obliquus* IBASU-A292, *Ch. vulgaris* IBASU-A189-192, *P. kessleri* IBASU-A 197-201 are well-know as producers of proteins, vitamins and other bioactive compounds. The application of some strains of *A. dimorphus*, *Ch. vulgaris*, *Chloroidium saccharophilum*, *Euglena gracilis, Monorophidium* (=*Ankistrodesmus*) sp.are high effective for development of the closed cycle water use as well as the treatment and post-treatment of different type of waste waters (Lenova, Stupina, 1990; Tsoglin et al., 1999). Thereby, aprofibility of algae within sufficient commercial value would be raised for account of their multiple-purpose usage. By turn, that demands some more additional investigations intended for a study of the specificity of mixed culture cultivation, mixotrophy in green algae, interactions between algae and their accompanying organisms etc.

Conclusions

A new collection of the high biomass producers including 33 strains of 18 species has been formed as the basis of feedstock for biodiesel production. The strains of *Chlorella vulgaris*, *Parachlorella kessleri*, *Acutodesmus dimorphus* and *Desmodesmus magnus* with increasing biomass in the range of 0.58 g·L^{-1} to 1.6 g·L^{-1}dry weight per day are the most perspective. Also, their biomass can be used for other chemistry industry feedstock.

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