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Review Article

THE PRODUCTIVITY OF *DUNALIELLA SALINA* ALGAE POPULATION IN ARTIFICIAL BALANCED MINERAL MEDIUM

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ABSTRACT
In this work have been presented the results of investigation of growth dynamics and bioproductivity of dunaliella cells population in artificial balanced mineral medium on base of masazir lake water as NaCl source with addition of $MgSO_4$, KNO_3, microelements and investigation of their suitability for intensive algae cultivation in laboratory installations.
It was shown, the artificial mineral medium, prepared on base of mazasir lake saline water, with different additions became suitable for the growth of cell population in intensive- accumulated cultivation regime.
It was determined that for mass cultivation of *Dunaliella* microalgae on base of saline lake Masazir, the minimal expense in preparing mineral medium, allows to increase the bioproductivity to 15-20% and to decrease to several times the cost of the last productivity.

Key Words: *Green Microalgae of Dunaliella, Balanced Mineral Medium, Bioproductivity, Cost Price*

INTRODUCTION
The cells of green microalgae Dunaliella are the important and suitable objects of modern photobiotechnology. Under intensive cultivation of *Dunaliella* in polyproductive installations one achieves high bioproductivity and from their biomass, can gain protein, carotenoids and bioproducts with vitamins Semenenko (Abdullayev, 1980). Changing the mineral contain of nutritive medium and cultivation condition by Dunaliella, it is possible directly to synthesize variousbiopreparations, vitamins which broadly are used in pharmacology and national economy (Massjuc *et al.*, 2007).
For the decrease of biomass cost price some authors recommend to cultivate the algae in concreted pools, filled with one-molar solution of sodium salt with the addition of sulphate acid ammonium, soil (Woscresenskiy, 1960).
Ukeles (1965) proposed to grow *Dunaliella* in fiberglass wins with 280L. capacity under solar solution as culture medium served the solution with sodium salt in piped water with the admixture urea (0, 02%), tris - hydroxyl – metylaminomethane (0, 2%), thiamine (0, 2mg/l) and phosphate.
It was also proposed Wisely, Purday (1961) mediums, containing sterile marine water, enriched with biogenic substances ($NaNO_3$, NaH_2PO_4) and soil extracts. The cost price of the last product –biomass rises in price because of the broad quantity of the used sodium salt to prepare mineral medium. A large amount of necessary non-organic salt (mainly NaCl, $MgSO_4$) leads to rise in price of the last product in order to grow these algae in productive ranges and influences on rentability.
For this purpose we have used and conducted water bodies of saline lake Absheron , and was determined that saline lake Masazir isn't contaminated with oil, oil products and potable water and its chemical composition advantagely contains: NaCl – 330q/l; MgCl – 2q/l; microelements with enough quantity.
Here includes the preparation of artificial balanced mineral medium on base of lake water as NaCl source with $MgSO_4$, KNO_3addition, microelements and the investigation of their suitability for the intensive cultivation of dunaliella cells in laboratory installations.

MATERIALS AND METHODS
As the investigation object, the green halophylic unicellular algae *Dunaliella salina* IPPAS D-294 was used, it was taken from the saline lake Absheron and added into the culture.

The algae were grown at 27^0C in photoreactions (1000 *ml*), in the installation to grow the culture of unicellular algae "UBKB". Mineral medium Abdullayev-Semenenko contains (q/l): NaCl – 87,5 (1,5M) KNO_3– 5,0; KH_2PO_4- 1,25; $MgSO_4$– 50; $FeSO_4$- 0,009 solution of microelements 1 ml/l. pH mineral medium was reached to pH=7,2-7,4 with the solution 0.1 n NaOH. The artificial balanced mineral medium was made from Masazir lake water, adding piped water 2 times; 3 times and 4 times, with following additions $MgSO_4$-10 q/l and; KNO_3- 1 q/l and the solution of microelements (1 ml/l). The suspension in photoreactors was illuminated day and night by white luminescent lamp (24 w| m^2), and regularly was blown by air mixture (air + 1, 5 % CO_2).
The growth temp of culture was determined periodically by the cell account in the Qoryayev camera under the microscope or nephelometric changes of optic density in suspension in spectrophotometre.
The pigment composition in cell extracts (100% acetone) was measured in spectrophotometre and considered on base of coefficient (Wetshtain and Qavrilenko, 1975).

RESULTS AND DISCUSSION

For the stabilization of mineral nutrition condition of algae within 3 days cultivation is necessary the Principe of balanced medium. Under balanced medium one understands such nutritive solutions, which the ratio of elements copied loss of minerals with biomass yields. Imbalanced medium, which is still used in mass algae cultivation, has several deficiencies, which strongly embarrass the stability of mineral nutrition condition. As the sample of imbalanced medium is used the medium Abdullayev - Semenenko, Semenenko (1980), with nitrate nitrogen containing significantly - loss of potassium, magnesium, sulphate. By including pH into the solution leads to the decrease of magnesium and phosphate Massjuc in the sediment (1973). Imbalance of ions under intensive cultivation can lead to respectable oppression of algae growth. Considering these conditions has been made artificial mineral medium on base of saline Masazir lake water, diluting 2; 3; 4 times in piped water and adding 10 q/l $MgSO_4$; 1 q/l KNO_3 and microelement solution. The important point for developing algae has correlation of ions Na/Mg. It was observed in the work Massjuc (1973), the chemical pure concentrated solutions of sodium chloride and sulfuric acidic magnesium in durable contact with halophylic algae influence on them poisoning; so in simultaneous presence in nutritive solution of both salt even high last concentrations aren't poisons. The growth and reproduction of *Dunaliella salina* are possible under broad amplitude of ratio Na^+/Mg^{++} (optimum is in 1, 3-1, 2 limits) Massjuc (1973).

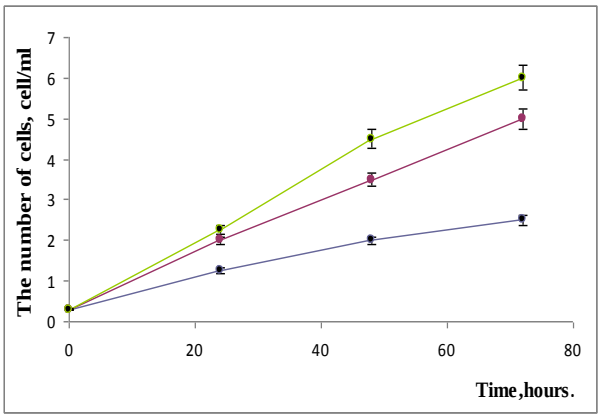

Figure 1: The growth of cells dynamics of cell *Dunaliella* population in artificial balanced mineral mediums, prepared on base of saline water of Masazir Lake:
1- Dilution 3 times + $MgSO_4$+ KNO_3; 2-dilution 4 times+ $MgSO_4$+ KNO_3; 3-dilution 2 times+ $MgSO_4$+ KNO_3;
Temperature 27^0C, light intensity 24w/m^2

Prepared artificial mineral mediums didn't demand alkalizing as in the medium of Abdullayev-Semenenko (ratio Na^{+}/Mg^{++} composed 1, 75) and were used immediately after preparation (Ph~7, 0).
In figure 1 have been presented the results of population growth dynamics of *Dunaliella* cells in artificial mineral mediums, prepared on base of saline water of Masazir lake, diluted to 2, 3, 4 times with addition 10 q/l $MgSO_4$ (ratio Na^{+}/Mg^{++} respectively 16, 5, 11, 8, 25) and 1q/l KNO_3. As seen from the figure the growth of cell population in artificial medium on base of saline water of Masazir lake diluted 3 times is ahead from the productivity of remaining experienced population in mineral medium with other dilutions. Perhaps, the medium with 3 times dilutions corresponds (osmotic pressure, made by ion content, optimal ratioNa^{+}/Mg^{++}) to classic medium.
Mineral medium, diluted 2 times, was high molar (ratio of Na^{+}/Mg^{++} higher optimal) and the bioproductivity of cell population was lower and contained 40% (curve 3) from optimal diluted medium (curve1). What concerns to mineral medium, prepared on base of saline lake water and diluted to 4 times (curve 2) where growth population was a little lower 15-20%, than in optimal diluted medium (curve 1).
Thus, the cells of *Dunaliella salina* are capable to show their own life ability in broad limits of saline concentration of the medium. Artificial mineral medium, prepared on base of saline Lake Masazir, with various dilutions seemed suitable to grow the population of *Dunaliella* cells in intensive- accumulated cultivation regime.

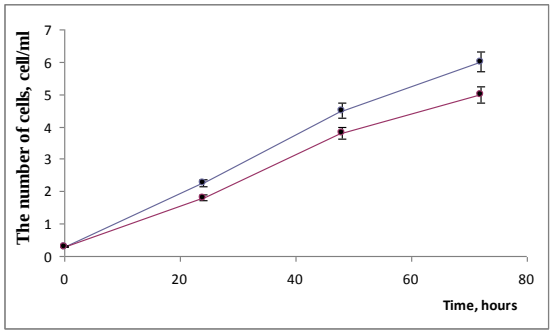

Figure 2: The growth dynamics of *Dunaliella* cell population in artificial balanced mineral medium (1) and Abdullayev-Semenenko medium (2): 1- dilution 1, 5 times+ $MgSO_4$+ KNO_3; 2 – whole medium of Abdullayev –Semenenko. Temperature 27^0C, light intensity 24 w/ m^2

The further task of our investigation was the comparative investigation of growth and the bioproductivity of algae population in artificial medium on base of saline water with 3 short multiple of dilution and classic Abdullayev- Semenenko medium. In fig. 2 were presented the investigation results of growth dynamic of *Dunaliella* cell population in artificial mineral medium (Semeneko and Abdullaev, 1980) and Abdullayev-Semenenko (Massjuc *et al.*, 2007).
As seen from figure, the comparative investigation of growth dynamics of *Dunalliella* cell population in artificial balanced mineral medium (Semeneko and Abdullaev, 1980) and Abdullayev-Semenenko medium (Massjuc *et al.*, 2007) showed, the algae development in artificial balanced medium (Semeneko and Abdullaev, 1980) higher to 15-20%, than in classic medium. Perhaps, it is connected with the loss of respectable quantity fall in sediment of magnesium phosphor (Massjuc, 1973), by including pH solution (alkalizing) during preparing nutritive solution.
In the culture growth process in artificial and classic mediums containing pigment and correlation (chlorophylls/carotenoids) in biomass were different. So, because of intensive culture growth in logarithmic- phase in artificial mineral medium absolute quantity of chlorophylls was higher to 10-15%, carotenoids to 5-10%, than in cells, grown in classic medium. The ratio of chlorophylls/carotenoids, characterizing the photosynthetic algae activity, also increased the meaning in cells, grown in classic

medium. As transition of culture into stationary phase, the number of carotenoids a little increased in both populations.

Thus, for mass cultivation of *Dunaliellla* microalgae on base of saline lake Masazir, under minimal costs in preparing mineral medium, allows increasing the bioproductivity of microalgae to 15-20% and several times decreasing the cost price of last product.

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