УДК 665.939.35

# ELECTROMAGNETIC BIOSTIMULATION OF PHYCOBILIPROTEINS CONTENT IN CYANOBACTERIA

***L.S. Tymoshenko*[1], *O.A. Vasylchenko*[2], *A.V. Lishchuk*[3], *I.M. Nezbrytska*[4], *P.P. Loshytsky*[5]**
[1,2]National Aviation University, Kosmonavta Komarova ave., 1, Kyiv, 03680, Ukraine
[3,4]Institute of Hydrobiology of the NAS of Ukraine,Heroiv Stalinhradu ave., 12, Kyiv, 04210,Ukraine
[5]Igor Sikorsky Kyiv Polytechnic Institute, Peremohy ave., 37, Kyiv, 03056, Ukraine

Phycobiliproteins are group of colored, highly fluorescent, water-soluble protein components commonly present in cyanobacteria (blue-green algae), red algae and cryptomonads. They are protein components of the photosynthetic light-harvesting antenna complexes. These proteins are classified into two groups based on their color: the phycoerythrins (red) and the phycocyanins (blue). The phycocyanins include C-phycocyanin (C-PC), R-phycocyanin (R-PC) and allophycocyanin (APC).

Phycobiliproteins have a wide spectrum of applications. They are extensively commercialized for fluorescent application in clinical, including immunological, analysis. For example, R-PC is a preferred marker for cytometry and Luminex systems. Phycobiliproteins therapeutic value has been demonstrated also. C-PC has potential use in the treatment of diseases caused by stress. It is antioxidant, which able to bind free radicals. Anti-inflammatory effectiveness of C-PC is comparable with non-steroid drugs. On the basis of the ability of C-PC prevent damage to neurons in the brain suggested to use it for the treatment of Alzheimer's and Parkinson's diseases. Phycobiliproteins are also used as natural colorants in food and cosmetics and replaced the synthetic colorants [1].

The prices of phycobiliproteins vary from US $ 3-25 $mg^{-1}$ for food/cosmetic grade pigments but they can reach US $ 1500 $mg^{-1}$ for highly purified molecular markers (with antibodies or other fluorescent molecules) [2]. So, in an attempt to better understand and manipulate microalgae for optimum phycobiliproteins production capacity, many researchers have investigated alternative methods for stimulating their growth and metabolic pathways.

Electromagnetic fields are capable of eliciting *in vivo* and *in vitro* effects in many biological systems. Increasing attention is being directed towards bioelectromagnetic stimulation of living cultures for biotechnology applications using the low frequency electromagnetic fields.

Research groups in Japan and China have focused on investigating the ways to improve the cultivation of cyanobacteria *Spirulina platensis* for the production of nutraceuticals using permanent magnetic fields. Hirano *et al.* reported significantly higher specific growth rate of 0.22 $d^{-1}$ in *S. platensis* exposed to 10 mT magnetic field when compared to 0.14 $d^{-1}$ for untreated culture. The growth of *S. platensis* was maximal when it was cultured phototrophically at lower light intensities; but did not show improvement under heterotrophic conditions [3].

Magnetic field induced growth stimulation in *S. platensis* has also been reported by Li *et al*. They observed a 47 % increase in dry biomass on the sixth day of cultivation, and a 22 % increase over control by day eight under the exposure of a 250 mT homogeneous magnetic field from a Helmholtz coil [3]. Hirano *et al*. opined that the treatment using magnetic field increased the phycocyanin content in *S. platensis,* which plays an important role in the activation of photosystem II to help the activation of electron transfer reactions during photosynthesis. Their results also suggested that the magnetic fields accelerate the light excitation of chlorophyll radical pair.

Singh *et al.* investigated the use of permanent magnets and found that the physiological response of cyanobacteria *Anabaena doliolum* was dependent on exposure time and magnetic pole orientation. They reported that N, S and N+S poles from 0.3 T permanent magnets produced different effects depending on the exposure time from 1 to 6 h. The effect was significant after two-hour exposure with combined N+S poles, where one culture was exposed to only N pole, which was then mixed with another culture exposed to S pole only. Treated cultures demonstrated 150, 110, 38, 34 and 20 % increase in phycocyanin, chlorophyll *a*, carbohydrates, carotenoid and protein content respectively and 55 % increase in optical density over the control [3].

Therefore, the electromagnetic fields are perspective for usage to increase the phycobiliproteins content in microalgae. It is very promising method for biotechnology.

*References*


1. Recent Developments in Production and Biotechnological Applications of C-Phycocyanin [Електронний ресурс] / M.Kuddus, P. Singh, G. Thomas, A. Al-Hazimi. // BioMed Research International. – 2013. – Режим доступу до ресурсу: https://www.hindawi.com/journals/bmri/2013/742859/
2. Effect of Varying Physicochemical Parameters on the Productivity and Phycobiliprotein Content of Indigenous Isolate Geitlerinema sulphureum [Електронний ресурс] / A. A. Kenekar, M. A. Deodhar. // Biotechnology. – 2013. –№12. – P. 146–154. – Режим доступу до ресурсу: http://docsdrive.com/pdfs/ansinet/biotech/2013/146-154.pdf
3. Electromagnetic Biostimulation of Living Cultures for Biotechnology, Biofuel and Bioenergy Applications [Електронний ресурс]/ [R. Ryan Hunt, A. Zavalin, A. Bhatnagar та ін.]. // International Journal of Molecular Sciences. – 2009. –№10. – Режим доступу до ресурсу: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2790121/