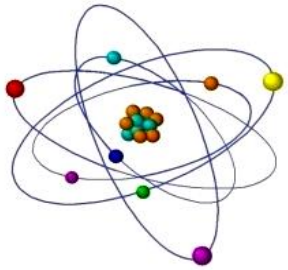
EFFECT HIGH DOSE OF Cs^{137} AND Co(II), Cd(II), Ag(I) IONS ON *Spirulina platensis*



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ABSTRACT: *Influence of metal ions Ag(I), Co(II), Cd(II) on Spirulina platensis and their constituent after high dose (400kGy) of Cs^{137} irradiation were studied using UV-VIS spectroscopy. It was shown that influence of metal ions Ag(I), Co(II), Cd(II) on Spirulina platensis and their constituents differs from each other its effectiveness. Effect high dose of Cs^{137} and Co(II), Cd(II), Ag(I) ions on Spirulina platensis study show that possible use of a high dose of gamma irradiation does not change the nature of the interaction of these metal ions for intact cells Spirulina patensis and its constituents.*

Key words: Spirulina platensis, metal ions, gamma-irradiation

INTRODUCTION

Spirulina was used as food by the Aztec civilization. It has been extensively studied for its nutraceutical value and is used as a food supplement. *Spirulina* contains various components that are beneficial for health, such as proteins, vitamins (such as pro-vitamin A, Bl, B2, B6, B12, E and D), essential amino acids, minerals, γ-linoleic acid, glycolipids, sulfolipids, and phycobilins (phycocyanin, allophycocyanin, and phycoerythrin). Khan et al. [1] reported the main bioactive molecules and explained in detail their effects on health and human nutrition. Furthermore, there are several studies reporting *Spirulina* therapeutic effects including the hypocholesterolemic effect [2]. It has some good medicinal properties against inflammation [3] and cancer [4], and cerebral ischemia [5], vascular reactivity [6], and anti-Parkinson [7]. Based on the findings, in work [8] were investigated whether *Spirulina platensis* supplementation can inhibit the development of liver fibrosis through its effect on inflammation and whole-body energy metabolism in a diet-induced mouse model of liver fibrosis. The expression and secretion of inflammatory genes in *splenocytes* were significantly reduced by *Spirulina platensis* supplementation, demonstrating the anti-inflammatory effects of *Spirulina platensis* in vivo. Although *Spirulina platensis* did not show appreciable effect on the prevention of liver fibrosis in this mouse model, it may be beneficial for other inflammatory conditions [8]. Numerous studies have suggested that zeaxanthin and lutein are crucial for visual health *Spirulina* can serve as a rich source of dietary zeaxanthin in humans [9].

A single dose of *Spirulina* can increase mean serum zeaxanthin concentration in humans from 0·06 to 0·15mmol/l,

Gamma irradiation has been used for microbial decontamination of food [10]. In [11] reported that gamma irradiation had a stimulatory effect on its growth and cellular constituents. In our works [12,13] influence of 7.2 kGy Cs^{137} gamma-irradiation have been studied with optical and differential scanning microcalorimetry (DSC) methods for cyanobacterium *Spirulina platensis* intact cells in the suspension, wet mass, and dry mass samples and also simultaneous effects of Cd(II), Pb(II) ions and γ-irradiation on stability of *Spirulina platensis* intact cells after 7.2 kGy Cs^{137} gamma irradiation and

without irradiation. In [14] combined effects of Cs^{137} gamma irradiation and heavy metal ions same concentrations on *Spirulina platensis* cells using UV-VIS spectrometry, when after one year the same *Spirulina platensis* (which was irradiated with 7.2 kGy one year ahead) again irradiated and recultivated were discussed.

In this work, we have studied simultaneous effects of a high dose (400kGy) Cs^{137}gamma irradiation and heavy metal ions Co(II), Cd(II), Ag(I) on *Spirulina platensis* intact cells after irradiation and recultivation and their constituents using UV-VIS spectrometry.

MATERIALS AND METHODS

Spirulina platensis IPPAS B–256 strain was cultivated in a standard Zarrouk [15] alkaline water–salt medium at 30ºC, illumination ~5000lux, at constant mixing in batch cultures [16]. The cultivation of the *Spirulina platensis* cells was conducted for 16 days. The growth was measured by optical density by monitoring of changes in absorption at wavelength 560nm using the UV–Visible spectrometer Cintra 10e. The intact cell suspension of *Spirulina platensis* at pH 10.1 in the nutrition medium was used for scanning the absorption spectra from 400 to 800nm. The concentration of *Spirulina platensis* was determined by the instrumental data [17, 18]. *Spirulina platensis* suspension (100 ml) has been irradiated with 400kGy gamma radiation from April to January, in the span of 10 months (Dose rate 0.018Gy/s) using ^{137}Cs as a gamma radiation source at the Applied Research Center, E. Andronikashvili Institute of Physics. Suspension after the irradiation (400 kGy) were filled up to 200ml with Zarrouk medium and they were recultivated for16 days. The optical density was measured every day with 24h intervals. The concentration of different compounds was estimated at the late exponential phase.

RESULTS AND DISCUSSIONS

Metal effect by irradiated and recultivated cells of blue-green microalgae *Spirulina platensis* was studied as a function of metal concentration (pH 10.1). Fig.1 shows the absorption characteristics after irradiation and recultivation of cells *Spirulina platensis*. The peak at 681 nm is due to the absorption of Chl a peak. At 621 nm is due to the absorption of phycocyanin (PC). At 500 nm is due to the absorption of carotenoids. A peak at 440 nm is due to soret band of Chla [19]. In fig.1 are shown effect of Cd(II), Co(II), Ag(I) ions on the absorption of the irradiation (400kGy) and cultivation cells after irradiation and cultivation of *Spirulina platensis*. It is seen from fig.1, that with increasing metal concentrations absorption intensity decreased for all metal ions. As can be seen from this figure, the absorption processes were relatively fast in the small concentrations for Cd(II), Co(II) and Ag(I) ions and then became slow. In [20] *Spirulina platensis* cells were exposed to different doses of gamma irradiation (Co^{60}). The optimum growth of *Spirulina platensis*was recorded at 2.0 kGy as compared to the control after the 14th day of incubation. The results of pigments analysis revealed that the chlorophyll *a* and carotenoid contents of *Spirulina platensis* reached their maximum rate at a dose of 2.0 kGy.

By us were also investigated the influence of the same metal ions on the same cellular components of *Spirulina platensis* the same irradiation dose. Effect of metal ions on the absorption intensity maximums for wavelengths 440nm, 500 nm, 621 nm and 681nm are shown in fig.2. At 440 nm with increasing Cd(II) and Ag(I) concentration the intensity of absorption increases, almost does not change for Co(II) ions. Increasing is very effectively for Cd(II) ions. Analogue results were received for carotenoids at 500 nm wavelengths in the case Cd(II), Ag(I), Co(II) ions. As for the change in absorption intensity at 621 nm, which is the peak of absorption of the major protein-phycocyanin of *Spirulina platensis*, as the concentration of silver ions increases, the absorption

intensity very efficiently increases, but almost does not change in the case for Cd(II) ions. An increase in the concentration of Co(II) causes the most noticeable decrease in the intensity of absorption intensity. It should be noted, that sequence of effectiveness first Ag(I), after that Cd(II) and after that Co(II) were observed for all constituents. Similar results were observed in absorption intensity for Ag(I) ions at 681 nm, which is the absorption peak of the Ch a of *Spirulina platensis*. In particular, as the concentration of silver ions increases the absorption intensity increases very efficiently. But unlike silver ions, an increase in the concentration of Co(II) and Cd(II) causes the most noticeable decrease in the intensity of absorption. If we consider that the maximum absorption of chlorophyll is 440 nm and 681 nm, then we can conclude that at both peaks of the chlorophyll absorption intensity of *Spirulina platensis* the above-mentioned metal ions act equally.

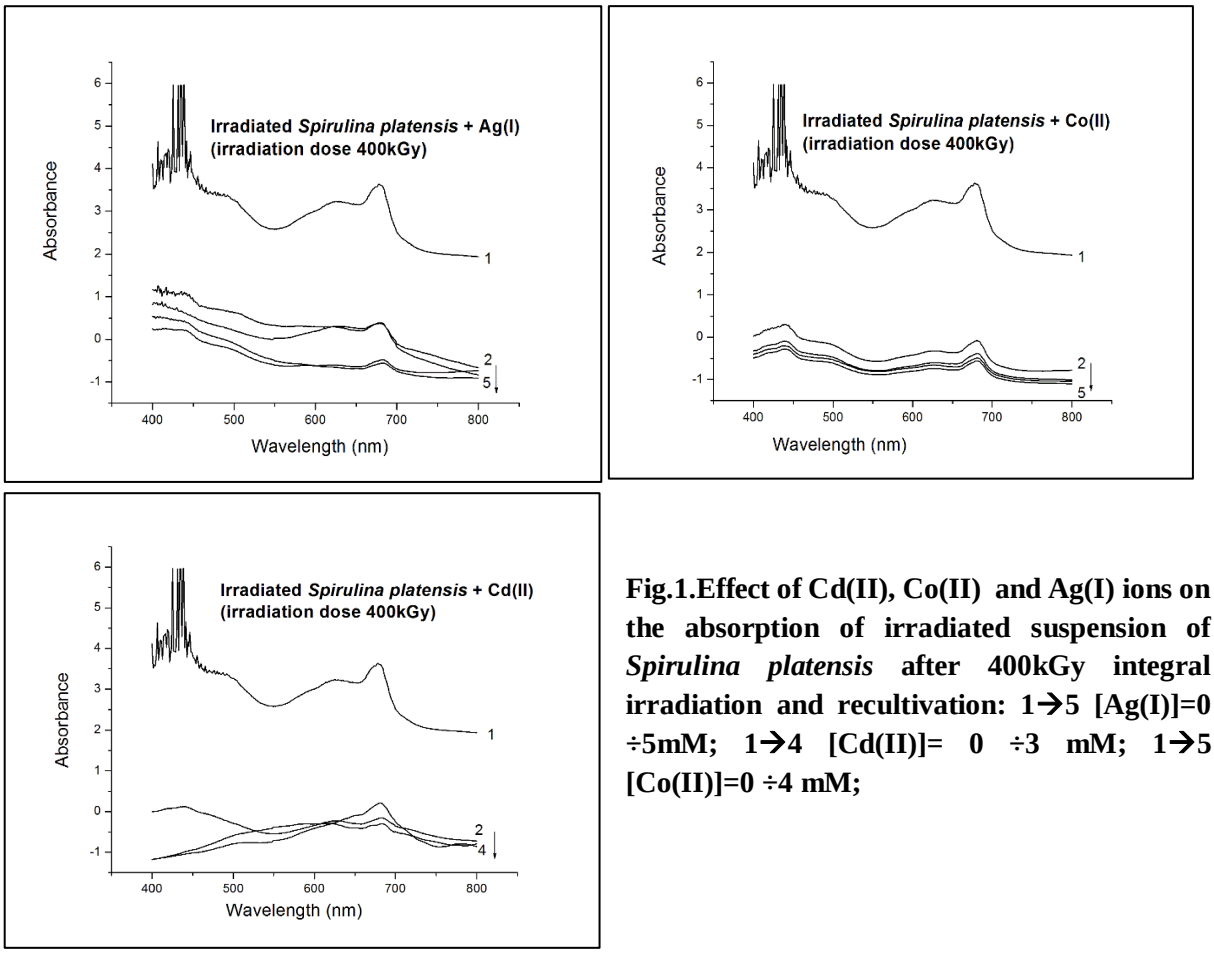

Fig.1.Effect of Cd(II), Co(II) and Ag(I) ions on the absorption of irradiated suspension of *Spirulina platensis* after 400kGy integral irradiation and recultivation: 1→5 [Ag(I)]=0 ÷5mM; 1→4 [Cd(II)]= 0 ÷3 mM; 1→5 [Co(II)]=0 ÷4 mM;

The role of *spirulina* orally administrated before or after whole body γ-irradiation on brain tissue is determined by FTIR-ATR and ESRThe role of *Spirulina* against brain tissue injury was discussed [21]. Thirty male albino whistler rats were divided. Deconvolution of secondary structure of amide I showed that 4Gy exerted significant increase in β-sheet. Electron spin resonance of lyophilized brain tissue indicated increase in the free radicals for 4Gy. *Spirulina* given before or after γ-irradiation ameliorate the changes in brain tissue.

If this results will be compared for the results which were received by us in works [13,22,23], for these metal ions in the case without irradiation, it is clear that the effectiveness of intact cells of cyanobacterium *Spirulina platensis* influence of metal ions (Ag(I), Co(II) is analogue for all the onstituents [22].

For silver ions, an increase in intensity is observed in both the irradiated after 3 times irradiation and recultivation) [23] and non-irradiated states [22].

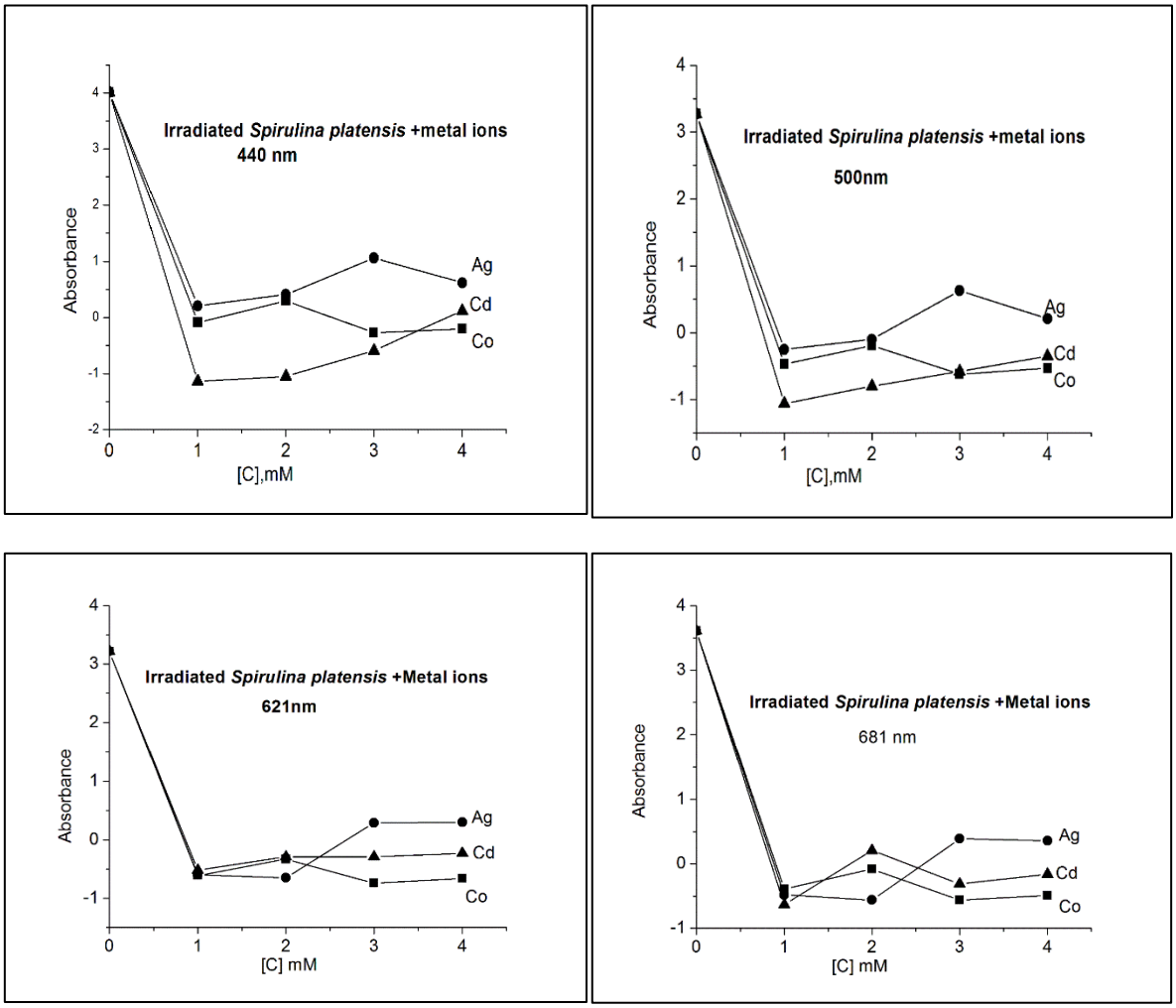

Fig.2. Changes in the absorption intensity of cellular constituents of irradiated *Spirulina platensis* at 621 nm (phycocyanin), at 440 nm (the soret band of Chl a), at 681 nm (the Chl a), at 500 nm (carotenoides) under the influence various metal ions after high dose (400kGy) integral irradiation and recultivation.

After 7.2 kGy 137Cs gamma irradiation and without irradiation it was shown that the addition of Cd(II) ions causes a decrease in optical absorption spectra band intensities. In the case of irradiation, the absorption band intensity decreases higher than without irradiation [13].

In work [24] was to investigate the tolerance and adsorption of five heavy metal ions by radiation-resistant microbes, a radiation-resistant strain NO.9 was identified according to 16S rDNA gene sequence analysis and biolog system, and the tolerance and adsorption to five heavy metal ions were analyzed. The results showed that it had a maximum tolerance of 2200mg/L to Pb2+, and it had adsorption ability to Pb2+、Cu2+、Hg2+、Zn2+ and Co2+under the situation as follows: 0.1g the amount of cells, at pH 6.0, 20°C and adsorbed for 40 min. it reached maximum adsorption. This 98.9% to Pb^{2+}, and the amount of adsorption was 39.56mg/g. It indicated that strain NO.9 had a strong tolerance and absorption to Pb^{2+}.

Thus, the effect high dose of Cs^{137} and Co(II), Cd(II), Ag(I) ions on *Spirulina platensis* study show that possible use ofa high dose of gamma irradiation together with Co(II),Ag(I) and Cd(II) ions do not change nature of the interaction of these metal ions for *Spirulina platensis*.

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