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CHANGES IN THE PIGMENT COMPOSITION OF *RHODOPSEUDOMONAS YAVOROVII* IMV B-7620 UNDER THE INFLUENCE OF HEAVY METAL SALTS

The aim *of the study was to clarify the changes in the pigment composition of Rhodopseudomonas yavorovii IMB B-7620 under the influence of ferric(III) citrate, cobalt(II) chloride, copper(II) chloride and potassium bichromate.* ***Materials and methods.*** *R. yavorovii IMV B-7620 bacteria were grown at + 27 ... + 30 °C for 14 days in ATCC No 1449 medium supplemented with 1.0–12.0 mM ferric(III) citrate, 1–15 mM cobalt(II) chloride, 0.050–0.500 mM copper(II) chloride, or 0.010–0.045 mM potassium dichromate. The bacterial cells were sedimented, resuspended in acetone, and disintegrated by sonication. The resulting suspension was kept for 24 hours at -20 °C, after which it was centrifuged, and 0.5 ml of supernatant were filtered through membrane filters (pore diameter 0.45 μm). Chromatographic separation of pigments was performed using a high-performance liquid chromatography system.* ***Results.*** *On the 14th day of cultivation under the influence of heavy metal compounds, the qualitative and quantitative changes in the pigment composition in R. yavorovii IMV B-7620 cells occurred. Under the influence of ferric(III) citrate, cobalt(II) chloride, and potassium dichromate, a decrease in the pigment content in R. yavorovii IMV B-7620 cells was detected. The content of lycopene decreased by 22.1–83.9%, bacteriochlorophyll a – by 33.8–86.0%, compared to the control. Under the influence of copper(II) chloride, not only the pigment content but also the quantity of its isomers increased. Under the influence of the studied metal compounds, a small amount of anhydrorhodovibrin was detected in the cells, whereas it was not detected in the control.* ***Conclusions.*** *Under the influence of heavy metal compounds, changes in the qualitative and quantitative composition of pigments occur in the cells of bacteria R. yavorovii IMV B-7620. Ferric(III) citrate, cobalt(II) chloride and potassium bichromate caused a decrease in the pigment content in R. yavorovii IMV B-7620 cells. Under the influence of copper(II) chloride, not only the content of pigments increased, but also the quantity of their homologues and isomers, in particular lycopene, which can perform a protective function. Under the influence of all the studied metal salts, a small content of anhydrorhodovibrin was detected in the cells, which was not detected in the control. It can also contribute to the protection of cells from stressors.*

Key words: carotenoids, bacteriochlorophyll a, iron, cobalt, copper, chromium

The biosynthesis of photosynthetic pigments by microorganisms is a process sensitive to many factors, including the influence of heavy metals [8], that inhibit the biosynthesis and accumulation of pigments due to enzymatic degradation [3]. The Hg, Cd, Cu, Pb, Ni, and Zn ions can replace Mg in the porphyrin ring of chlorophyll or bacteriochlorophyll molecules, resulting in its inactivation in the process of photosynthesis [11]. High content of Ni(II) or Zn(II) inhibits the synthesis of photosynthetic pigments and disrupts the photosynthetic apparatus [11]. Photosynthetic bacteria of the phyla *Chlorobiota*, *Acidobacteriota*, *Bacillota*, *Cyanobacteriota*, *Pseudomonadota*, *Chloroflexota,* and *Gemmatimonadota* [9, 15] may serve as model systems for studying the physiology, biochemistry and molecular biology of photosynthesis [15]. Among them, purple phototrophic bacteria, which have a flexible metabolism, are the most interesting in terms of their practical use in various biotechnologies [14]. In particular, the purple nonsulfur bacteria *Rhodopseudomonas yavorovii* IMV B-7620, isolated from the technologically created Yavorivske Lake (Lviv region, Ukraine), are characterized by significant biotechnological potential. *R. yavorovii* IMV B-7620 can be heterotrophic or autotrophic, depending on the light conditions, oxygen level, carbon sources, and electron donors. These bacteria can use a variety of organic compounds (alcohols, carbohydrates, fatty acids, amino acids, and toxic aromatic organic compounds) [25]. An important physiological and biochemical feature of bacteria of the genus *Rhodopseudomonas* is the capability for CO_2 fixation in the Calvin cycle and nitrogen fixation [14]. *R. yavorovii* IMV B-7620 are efficient exoelectrogens and H_2 producers during growth on the wastewater of different origins [25]. The pigment formation in photosynthetic microorganisms under the influence of heavy metals, which can be present both in the environment and in wastewater, has been studied insufficiently. Therefore, the aim of the study was to clarify the changes in the pigment composition of *R. yavorovii* IMB B-7620 under the influence of ferric(III) citrate, cobalt(II) chloride, copper(II) chloride and potassium bichromate.

Materials and methods

Bacteria *R. yavorovii* IMV B-7620 were grown at a temperature of + 27 ... + 30 °C and an illuminance of 200 lux in 250 ml flasks with 200 ml of modified medium ATCC No 1449 [25]. Na_3-citrate at a concentration of 12 mM, which was optimal for the growth of these bacteria, was added to the medium as a carbon source. To study the effect of metals on *R. yavorovii* IMV B-7620 cells, the corresponding salts were added to the ATCC No 1449 medium: $FeC_6H_5O_7$ – at concentrations 1.0; 3.0; 6.0; 9.0; 12.0 mM (the total citrate concentration was 12 mM); $CoCl_2 \times 6H_2O$ – at concentrations 1.0; 5.0; 10.0; 15.0 mM; $CuCl_2 \times 2H_2O$ – at concentrations 0.050; 0.100; 0.125; 0.250; 0.500 mM; $K_2Cr_2O_7$ – at concentrations 0.010; 0.0175; 0.025; 0.0375; 0.045 mM. Instead of metal salts, sterile distilled water was added to the control.

To obtain pigment samples, *R. yavorovii* IMV B-7620 was cultured in modified ATCC No 1449 medium for 14 days, then separated from the culture medium by centrifugation (2600 g, 20 min). The supernatant was removed, and the cells were resuspended in acetone and disrupted at 0 °C by sonication (using an ultrasonic disintegrator UZDN-2T, at 22 kHz, 5 min). The resulting suspension

was transferred to 2 ml Eppendorf microtubes and incubated for 24 h at -20 °C. The cell extracts were then centrifuged (1800 g, 10 min). Pigment extracts were obtained after filtering known volumes of supernatant through membrane filters (pore diameter 0.45 μm). All manipulations were performed at room temperature and without direct sunlight to avoid photooxidation of the pigments. Pigments were separated using high-performance liquid chromatography as described [2]. The pigments were determined by their absorption spectra recorded using a spectrophotometric detector with a photodiode array according to the literature [4, 6, 7, 20]. The conditional unit of pigment content was the peak area per gram of biomass. Biomass was determined turbidimetrically (λ = 660 nm) and calculated using the coefficient obtained by the weight method.

Statistical processing of the research results and visualization were performed using "Microsoft Excel 2016" and "OriginPro 8.5". The results are presented as mean values corrected for standard deviation (x±SD). The reliability of the data and the differences between them were estimated by the Student's coefficient. The difference was considered significant at a significance level of $p \leq 0.05$ [1].

Results

The pigment content of *R. yavorovii* IMV B-7620 cells was studied on the 14th day of culture growth. The peaks obtained on the chromatogram were characterized by their retention time, spectra, and absorption maxima (Table 1).

During cultivation of *R. yavorovii* IMV B-7620 in ATCC No 1449 medium without metals, 7 isomeric forms of lycopene were detected, among which the peak of lycopene 5 had an area 15.9%, lycopene 6 – 11.7%, lycopene 7 – 11.1% (Table 2). The peaks of other isomeric forms of lycopene had an area of 0.3–2.0% of all peaks detected at λ=474 nm. In *R. palustris* 42OL, lycopene is the main carotenoid (46.6 to 54.0% of the total carotenoid content), detected in cells grown under both aerobic and anaerobic conditions. Besides it, rhodopin, rhodovibrin, spiriloxanthin, and anhydrorhodovibrin are also found in cells of this strain [19]. In the work [2], anhydrorhodovibrin was detected in *R. yavorovii* IMV B-7620 cells on the 7th day of cultivation. However, we have not observed this peak on the 14th day of cultivation in a metal-free medium.

Among the homologues of bacteriochlorophyll *a*, the highest content of bacteriochlorophyll *a* of the third (28.2 % of all peaks at λ = 770 nm) and fifth (33.6% of all peaks at λ = 770 nm) homologous forms was found in *R. yavorovii* IMV B-7620 cells (Table 4). Bacteriochlorophyll *a* in most purple bacteria is the only pigment of the photosynthetic reaction center, although it is known that bacteriochlorophyll *b* is found in *Rhodopseudomonas viridis*, *Rhodopseudomonas sulfoviridis* [23].

When metal salts were added to the culture medium, changes in the qualitative and quantitative composition of pigments of *R. yavorovii* IMV B-7620 were detected.

Under the influence of all studied concentrations of cobalt(II) chloride, the quantity of lycopene isomers decreased from seven to five (Table 2). Under the influence of 1.0 and 5.0 mM cobalt(II) chloride, peaks of anhydrorhodovibrin were detected (Table 3). No changes in the quantity of bacteriochlorophyll *a* homologues were detected under the influence of this salt (Table 4).

Table 1

Characterization of pigments from *Rhodopseudomonas yavorovii* IMV B-7620 cells under the influence of metal salts

Pigment*	Isomeric/homologous form	Retention time, min	UV λmax, nm
Lycopene	1	20.9–23.6	448/472/501
	2	28.1–30.7	447/472/503
	3	30.8–31.7	449/472/500
	4	31.7–33.0	447/472/502
	5	41.0–42.6	448/472/503
	6	41.6–42.8	447/472/503
	7	50.7–52.5	447/472/502
	8	19.7–22.4	448/472/501
	9	25.6–27.3	448/472/501
	10	12.5–12.8	447/472/503
	11	32.7–33.6	448/472/502
	12	30.9–31.6	447/472/502
	13	20.4–21.2	447/472/503
	14	25.9–26.4	447/472/502
	15	29.3–29.4	447/472/503
	16	16.8–17.2	448/472/502
Anhydrorhodovibrin	1	35.0–37.0	461/485/516
	2	40.8–42.2	461/486/516
	3	35.0–36.2	461/485/516
	4	24.4–26.0	461/485/516
	5	47.1–47.6	461/484/516
	6	46.6–46.7	461/485/516
Bacteriochlorophyll *a*	1	28.2–31.3	361/605/770
	2	34.3–35.3	361/604/770
	3	37.1–39.1	361/605/770
	4	35.0–36.7	362/600/770
	5	36.4–38.8	362/605/770
	6	31.0–33.9	361/605/770
	7	28.4–29.4	361/605/770

Note. * – Pigments were identified according to the literature data [4, 6, 7, 20]

Table 2

Lycopene isomers detected in *Rhodopseudomonas yavorovii* IMV B-7620 cells under the influence of metal salts

Metal salt	Concentration, mM	Lycopene isomers															
		Peak area, % of all detected															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
-	0	0.3	2.0	1.2	1.7	15.9	11.7	11.1	-	-	-	-	-	-	-	-	-
$CoCl_2$	1.0	-	3.5	-	0.8	21.2	20.8	13.8	-	-	-	-	-	-	-	-	-
	5.0	-	2.4	-	0.4	17.1	11.6	7.7	-	-	-	-	-	-	-	-	-
	10.0	-	1.2	-	0.6	13.2	8.9	6.7	-	-	-	-	-	-	-	-	-
	15.0	-	0.4	-	0.2	6.4	5.8	4.9	-	-	-	-	-	-	-	-	-
$FeC_6H_5O_7$	1.0	0.3	-	2.1	2.1	5.7	4.3	26.5	-	-	-	-	-	-	-	-	-
	3.0	0.8	-	2.5	2.0	4.6	3.6	7.3	-	-	-	-	-	-	-	-	-
	6.0	-	-	1.2	1.3	3.4	3.1	6.5	-	-	-	-	-	-	-	-	-
	9.0	-	2.1	1.0	1.0	6.8	6.1	7.9	-	-	-	-	-	-	-	-	-
	12.0	-	0.5	-	0.7	7.7	4.6	16.8	-	-	-	-	-	-	-	-	-
$CuCl_2$	0.050	0.5	3.4	3.5	1.6	-	28.6	11.8	0.5	0.1	-	-	-	-	-	-	-
	0.100	0.4	2.9	0.5	2.9	-	32.5	12.7	-	0.3	0.09	2.0	-	-	-	-	-
	0.125	0.3	2.0	1.9	1.3	13.6	14.2	10.7	0.3	-	-	1.0	-	-	-	-	-
	0.250	0.08	3.1	1.8	2.4	-	31.1	12.3	0.06	0.1	-	2.2	0.7	0.09	0.2	3.0	-
	0.500	1.4	-	-	-	4.3	-	1.9	1.7	1,6	0.8	-	1.9	0.8	0.5	-	0.3
$K_2Cr_2O_7$	0.010	-	-	-	1.4	9.7	7.5	11.4	-	-	-	-	-	-	-	-	-
	0.0175	-	0.004	-	-	4.9	3.3	30.0	-	-	-	-	-	-	-	-	-
	0.0250	-	2.6	-	1.0	9.8	7.6	5.9	-	-	-	-	0.6	0.3	-	-	-
	0.0375	0.5	2.8	-	1.7	15.2	9.3	6.9	0.3	0.7	-	-	0.9	-	-	-	-
	0.0450	0.4	1.5	-	0.9	9.3	6.9	8.7	-	-	-	-	0.6	-	-	-	-

Table 3

Anhydrorhodovibrin isomers detected in *Rhodopseudomonas yavorovii* IMV B-7620 cells under the influence of metal salts

Metal salt	Concentration, mM	Anhydrorhodovibrin isomers					
		Peak area, % of all detected					
		1	2	3	4	5	6
-	0	-	-	-	-	-	-
$CoCl_2$	1.0	1.9	-	-	-	-	-
	5.0	0.9	-	-	-	-	-
	10.0	-	-	-	-	-	-
	15.0	-	-	-	-	-	-
$FeC_6H_5O_7$	1.0	1.6	2.5	3.4	-	-	-
	3.0	1.4	-	2.9	-	-	-
	6.0	-	-	-	-	-	-
	9.0	0.7	-	1.4	-	-	-
	12.0	-	-	-	-	-	-
$CuCl_2$	0.050	-	-	-	0.06	-	-
	0.100	-	4.8	-	0.2	-	-
	0.125	-	2.7	-	0.07	-	-
	0.250	3.2	4.2	-	0.09	-	-
	0.500	-	-	-	0.7	0.2	-
$K_2Cr_2O_7$	0.010	1.8	-	3.7	-	1.4	-
	0.0175	2.1	-	3.9	-	2.7	2.7
	0.0250	0.9	-	2.3	-	-	-
	0.0375	0.9	-	2.1	-	-	-
	0.0450	1.1	-	2.9	-	-	-

Table 4

Homologues of bacteriochlorophyll *a* detected in *Rhodopseudomonas yavorovii* IMV B-7620 cells under the influence of metal salts

Metal salt	Concentration, mM	Homologues of bacteriochlorophyll *a*						
		Peak area, % of all detected						
		1	2	3	4	5	6	7
-	0	2.7	4.4	27.8	4.0	32.5	-	-
$CoCl_2$	1.0	3.5	1.9	34.6	-	39.8	0.5	-
	5.0	1.9	2.4	20.5	-	26.6	0.3	-
	10.0	1.3	4.6	11.6	3.2	14.9	-	-
	15.0	1.1	3.8	9.2	1.7	12.0	-	-
$FeC_6H_5O_7$	1.0	4.2	3.5	27.0	-	36.7	0.3	3.0
	3.0	3.5	2.1	22.9	-	30.8		2.9
	6.0	1.7	2.2	15.2	-	20.9	0.1	1.3
	9.0	1.9	2.5	15.4	-	22.0	0.1	1.5
	12.0	2.7	-	19.3	-	26.7		1.6
$CuCl_2$	0.050	5.2	-	33.0	-	30.2	0.6	-
	0.100	0.7	-	29.0	16.7	-	2.3	-
	0.125	-	7.2	11.3	-	11.5	-	1.2
	0.250	5.8	-	23.9	15.2	-	-	-
	0.500	3.9	-	4.4	26.3	17.1	-	4.1
$K_2Cr_2O_7$	0.010	3.5	-	24.1	-	31.6	-	-
	0.0175	3.5	3.8	21.2	-	27.7	-	1.8
	0.0250	3.1	-	20.7	-	26.6	-	1.4
	0.0375	2.9	-	28.8	-	37.2	-	-
	0.0450	3.2	4.4	22.5	-	28.7	-	-

Under the influence of ferric(III) citrate, the quantity of lycopene isomers in *R. yavorovii* IMV B-7620 cells decreased from seven to six or five (Table 2). Under the influence of 1.0 mM of this salt, three isomers of anhydrorhodovibrin were detected, the peaks of which had an area of 7.5% of all peaks detected at λ=474 nm (Table 3). Under the influence of 12.0 mM ferric(III) citrate, the quantity of lycopene isomers decreased from seven to five, and bacteriochlorophyll *a* homologues from five to four (Table 2, 4).

Under the influence of 0.010–0.0175 mM potassium dichromate, the quantity of lycopene isomers decreased from seven to four, but anhydrorhodovibrin isomers were detected (Table 2, 3). At higher concentrations of this salt, the quantity of lycopene isomers increased to five or six. The number of bacteriochlorophyll *a* homologues under the influence of potassium dichromate was lower than in the control (Table 4).

Under the influence of copper(II) chloride, significant differences in the quantity of lycopene isomers were found (Table 2). While in the control there were seven lycopene isomers, under the influence of 0.050 mM copper(II) chloride there were eight of them, and under the influence of 0.500 mM – twelve isomers. The quantity of bacteriochlorophyll *a* homologues increased to six only under the influence of 0.500 mM copper(II) chloride, and under other concentrations it didn't differ or was fewer than in the control (Table 4).

The amount of the homologous forms or isomers of pigments is not a taxonomic feature but rather indicates the physiological state of the culture [4]. We assume that the change in the number of homologous forms or isomers of *R. yavorovii* IMV B-7620 pigments under the influence of metal salts is an adaptation of the culture to its effects.

In addition to the number of isomers and homologues, the content of pigments in *R. yavorovii* IMV B-7620 cells changed under the influence of heavy metal salts compared to the control. The pigment content in *R. yavorovii* IMV B-7620 cells differed depending on the metal in the medium and its concentration (Fig. 1).

Under the influence of 1.0 mM cobalt(II) chloride, the lycopene content increased by 1.38 times compared to the control. The content of bacteriochlorophyll *a* did not change compared to the control. As the concentration of cobalt(II) chloride increased from 5.0 to 15.0 mM, the content of all pigments decreased significantly. Under the influence of 5.0–15.0 mM cobalt(II) chloride, the content of lycopene decreased by 35.3–82.1%, bacteriochlorophyll *a* – by 56.2–86.0%, compared to the control (Fig. 1A).

Similar changes were found under the influence of ferric(III) citrate. When 1.0 mM of this salt was added to the culture medium, the content of lycopene and bacteriochlorophyll *a* in the cells didn't differ from the control. A small amount of anhydrorhodovibrin was detected. However, as the salt concentration increased from 3.0 to 12.0 mM, the content of all pigments decreased significantly. Under the influence of 3.0–12.0 mM ferric(III) citrate, the content of lycopene decreased by 59.4–83.9%, bacteriochlorophyll *a* – by 37.7–72.2%, compared to the control (Fig. 1B).

A decrease in the pigment content in *R. yavorovii* IMV B-7620 cells was also detected under the influence of all concentrations of potassium dichromate,

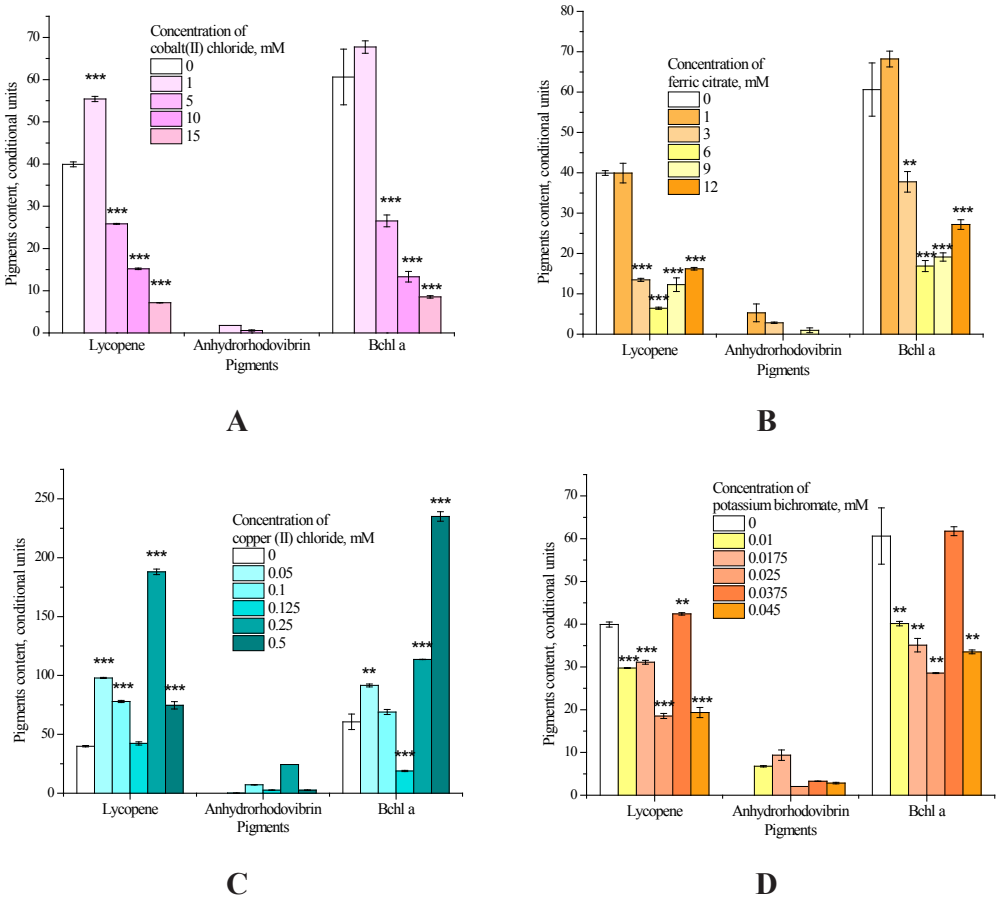

Fig. 1. Pigment content in *Rhodopseudomonas yavorovii* IMV B-7620 cells under the influence of cobalt(II) chloride (A), ferric(III) citrate (B), copper(II) chloride (C), potassium dichromate (D)

(x±SD, n = 3, ** – p≤0.01, *** – p≤0.001 – a significance level of changes compared to control)

except 0.0375 mM. Under the influence of potassium dichromate, the content of lycopene decreased by 22.1–53.6%, and bacteriochlorophyll *a* – by 33.8–52.8%, compared to the control. Under the influence of 0.0375 mM potassium dichromate, the content of lycopene and bacteriochlorophyll *a* was 2–6 % higher than that of the control (Fig. 1D).

Under the influence of copper(II) chloride, the pigment content in *R. yavorovii* IMV B-7620 cells increased compared to the control. Mostly, the increase in lycopene content is related to the increase of lycopene 6 percentage. A decrease in the content of lycopene and bacteriochlorophyll *a*, compared to the control, was found under the influence of 0.125 mM copper(II) chloride (Fig. 1C).

In the photosynthetic apparatus of anoxygenic purple bacteria, bacteriochlorophylls *a* or *b* and carotenoids (C_{40}) are responsible for light absorption, energy transfer from light-harvesting complexes to reaction centers, electron transfer to the

reaction center (bacteriochlorophylls), and photoprotection (carotenoids) [15, 24]. Lycopene is involved in a variety of chemical reactions that prevent the degradation of important cellular biomolecules, including lipids, proteins, and DNA, which ensures the antioxidant role of this carotenoid [13, 18]. Due to the presence of unsaturated double bonds, lycopene undergoes oxidative degradation or isomerization in response to environmental changes. Under the influence of environmental factors, including different light intensity, oxygen level, temperature, pH, and precence of Cu^{2+} or Fe^{3+} ions, seven of the eleven double bonds of lycopene can undergo mono- or poly-*cis*-isomerization, which affects its bioavailability [13, 22]. It is known that copper stimulates the synthesis of carotenoids in *Myxococcus xanthus* [17].

Zechmeister noted the possible presence of 72 geometric isomers of lycopene [5]. In bacteria, 3-*cis*-lycopene, 5-*cis*-lycopene, 7-*cis*-lycopene, and 9-*cis*-lycopene were detected [10]. As a result of lycopene *cis*-isomerization, the pigment retention time on the chromatogram is reduced, and a hypsochromic shift of absorption maxima in the pigment spectrum occurs [12]. Our results suggest the presence of a large quantity of lycopene *cis*-isomers in *R. yavorovii* IMV B-7620 cells under the influence of copper(II) chloride.

The physicochemical properties and bioavailability of *all-trans*- and *cis*-isomers of lycopene differ. *Cis*-isomers of lycopene are more bioavailable than the native *all-trans*-form. Lycopene and other carotenoids *in vitro* prevent peroxidation processes caused by singlet oxygen and peroxyl radicals. Particularly, the isomerization of *all-trans*-lycopene to its *cis*-isomers improves the scavenging of peroxyl radicals [18].

The detected peaks of bacteriochlorophyll in *R. yavorovii* IMV B-7620 cells, identified as bacteriochlorophyll *a*, differed in the retention time. We assume that this is bacteriochlorophyll *a*, esterified by various phytol derivatives. In *Rhodobacter sphaeroides*, minor peaks of bacteriochlorophyll *a*, that had the same absorption spectra but differed in the retention time, were identified as bacteriochlorophyll *a* esterified with geranylgeraniol, dihydrogeranylgeraniol or tetrahydrogeranylgeraniol [23]. Bacteriochlorophylls *a* and bacteriopheophytins *a* esterified with geranylgeraniol, dihydrogeranylgeraniol, tetrahydrogeranylgeraniol, and phytol were found in six phylogenetically distinct classes of purple bacteria, including bacteria of the genus *Rhodopseudomonas* [16]. Because geranylgeraniol is more unsaturated than the other three alcohols mentioned, it is more susceptible to free radical damage.

Thus, under the influence of heavy metal compounds, changes in the qualitative and quantitative composition of pigments occur in the cells of bacteria *R. yavorovii* IMV B-7620. Ferric(III) citrate, cobalt(II) chloride and potassium bichromate caused a decrease in the pigment content in *R. yavorovii* IMV B-7620 cells. Under the influence of copper(II) chloride, not only the content of pigments increased, but also the quantity of their homologues and isomers, in particular lycopene, which can perform a protective function. Under the influence of all the studied metal salts, a small content of anhydrorhodovibrin was detected in the cells, which was not detected in the control. It can also contribute to the protection of cells from stressors.

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ЗМІНИ ПІГМЕНТНОГО СКЛАДУ *RHODOPSEUDOMONAS YAVOROVII* ІМВ В-7620 ЗА ВПЛИВУ СОЛЕЙ ВАЖКИХ МЕТАЛІВ

Реферат

Метою *роботи було з'ясувати зміни пігментного складу Rhodopseudomonas yavorovii ІМВ В-7620 за впливу ферум(ІІІ) цитрату, кобальт(ІІ) хлориду, купрум(ІІ) хлориду та калій біхромату.* ***Матеріали і методи.*** *Бактерії R. yavorovii ІМВ В-7620 вирощували за температури + 27 ... + 30 °С упродовж 14 діб у середовищі АТСС № 1449, у яке вносили 1,0–12,0 мМ ферум(ІІІ) цитрату, 1,0–15,0 мМ кобальт(ІІ) хлориду, 0,050–0,500 мМ купрум(ІІ) хлориду чи 0,010–0,045 мМ калій біхромату. Клітини бактерій відокремлювали від середовища центрифугуванням, ресуспендували в ацетоні та руйнували на ультразвуковому дезінтеграторі. Отриману суспензію витримували упродовж 24 год за температури -20 °С, після чого центрифугували і 0,5 мл супернатанту фільтрували крізь мембранні фільтри (діаметр пор 0,45 мкм). Хроматографічне розділення пігментів здійснювали за допомогою системи високоефективної рідинної хроматографії.* ***Результати.*** *На 14 добу культивування за впливу сполук важких металів у клітинах бактерій R. yavorovii ІМВ В-7620 відбуваються зміни якісного та кількісного складу пігментів. За впливу ферум(ІІІ) цитрату, кобальт(ІІ) хлориду та калій біхромату виявлено зниження вмісту пігментів у клітинах R. yavorovii ІМВ В-7620. Вміст лікопіну знижувався на 22,1–83,9%, бактеріохлорофілу а – на 33,8–86,0%, порівняно із контролем. За впливу купрум(ІІ) хлориду зростав не лише вміст пігментів, а й кількість їхніх ізомерів. За впливу сполук досліджених металів у клітинах виявлено невеликий вміст ангідророродовібрину, який не виявляли у контролі.* ***Висновки.*** *За впливу сполук важких металів у клітинах бактерій R. yavorovii ІМВ В-7620 відбуваються зміни якісного та кількісного складу пігментів. Ферум(ІІІ) цитрат, кобальт(ІІ) хлорид та калій біхромат спричиняли зниження вмісту пігментів у клітинах R. yavorovii ІМВ В-7620. За впливу купрум(ІІ) хлориду зростав не лише вміст пігментів, а й кількість їхніх гомологів та ізомерів, зокрема лікопіну, який може виконувати захисну функцію. За впливу всіх досліджених солей металів у клітинах виявлено невеликий вміст ангідророродовібрину, який не виявляли у контролі. Очевидно, що це може також сприяти захисту клітин від стресових чинників.*

Ключові слова: каротиноїди, бактеріохлорофіл а, ферум, кобальт, купрум, хром

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