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IMPACT OF TRANSPORTATION AND ENVIRONMENTAL CHANGE ON THE LEVELS OF GLUCOCORTICOIDS, ELECTROLYTES AND OSMOLARITY OF THE BLOOD OF CARP (*CYPRINUS CARPIO* L.)

WPŁYW TRANSPORTU I ZMIANY ŚRODOWISKA NA POZIOM GLIKOKORTYKOIDÓW, ELEKTROLITÓW I OSMOLARNOŚĆ KRWI KARPIA (*CYPRINUS CARPIO* L.)

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The present studies revealed that the transportation and the associated change of environment, causing statistically significant cortisol level rise, led to the increase of sodium- and chloride-ion levels and osmolarity, as well as to the fall of potassium-ion concentration in the blood of carp. Despite the persistence of the high level of cortisol in the blood of carp, throughout the whole 7-day-long monitored period, the levels of Na^+, Cl^-, and the blood osmolarity came back to normal. The exception were potassium ions, whose concentration on the 7th day after the transfer were still statistically lower than the initial values.

INTRODUCTION

Ionic composition of the body fluids of fishes depends on a number of environmental factors. Among the crucial ones are: salinity of water (Eddy 1981), its temperature (Kłyszejko 1986), and the degree of contamination (Andrew 1989).

Because the ion-osmotic regulation in fishes proceeds under control of many hormones, among which the most important role play prolactin, glucocorticoids, and catecholamines, it seems possible that also the other factors of the environmental aggression are able to influence their electrolyte balance. It has been know, that during the action of various environmental aggression factors, the hypothalamus-pituitary-interrenal system becomes activated what in turn triggers intensive secretion of catecholamines and glucocorticoids (Thomas 1990).

The aim of the present study was to determine the impact of transportation and the cortisol released under its course, on the electrolyte level and osmolarity of the carp blood, as well as the evaluation of the recovery time, between the transfer accompanied by environmental change and the return of the studied parameters to the initial values.

MATERIAL AND METHODS

The experiment was carried out on clinically healthy carp individuals in the age of 1+, with masses of 610 ±70 g. The carp originated from a fish farm located in the thermal-effluent, post-cooling channel of the Dolna Odra power plant. The fish were transported for 1 hour in 60-liter barrels, 10 fish in each barrel. Upon the arrival, the fish were placed in 400-liter glass tanks, 15 fish in each. The temperature of the water, constantly aerated starting 4 days prior the experiment, had been maintained at 22°C, which was identical with the water temperature in the channel. Blood for the studies was sampled from the caudal vein within 7:30 – 8:00 AM before and after the transfer and on the 1st, 4th, and 7th day since its completion. Each sampling was based on 15 fish. The blood serum was studied for concentrations of:

1. Cortisol – employing the radioimmunological method, with use of ^{125}J Cortisol from a reagent set by Orion Diagnostica Finland.
2. Na^+ and K^+ ions – with photometric method, using flame photometer Flapho-4.
3. Chloride ions – using Spexon 100 Cl.
4. Osmolarity – on an automatic microosmometer by Knauer.

The results were statistically processed using Statgraphics® computer software (version 5.0).

RESULTS AND DISCUSSION

The acquired results are presented in the Table 1.

The present studies revealed that the transportation caused statistically significant ($P<0.01$) increase of cortisol levels in the blood of the carp. The associated change of environment, despite of similar water parameters before and after the transportation, prolonged the period of recovery of the studied hormone levels beyond the 7-day-long period monitored in the present experiment.

Analyzing the impact of transportation and the environment changes which caused statistically significant rise of the cortisol level, on the concentrations on the basic electrolytes and on the osmolarity of the carp blood, it was revealed that these factors caused statistically significant ($P<0.01$; 0.05) changes in Na^+, K^+, and Cl^- concentrations and in the osmolarity of blood. The greatest differences, in the relation to the basic levels occurred immediately after the transportation. These differences were decreasing in time and on the

7th day after the transport only K^+ level was still statistically significantly ($P<0.01$) lower from the level observed before the beginning of the experiment.

Table 1

Impact of transportation and the associated change of environment on the level cortisol on the concentration of sodium, potassium and chloride ions, as well as on the osmolarity of the carp blood, $\bar{x}$ ±SD

Component	Before	After	Days (24 h) in the altered environment		
			1	4	7
	n = 15	n = 15	n = 15	n = 15	n = 15
Cortisol (µmol/l)	60.7 ±10.5	873.3 ±240.9**	720.4 ±320.6**	630.0 ±256.2**	209.3 ±90.7**
Na (mEq/l)	138.2 ±12.4	158.7 ±12.2**	152.2 ±10.7**	149.1 ±10.9**	138.9 ±5.8
K (mEq/l)	3.18 ±0.28	1.85 ±0.16**	2.09 ±0.18**	2.15 ±0.20**	2.32 ±0.27**
Cl (mEq/l)	122.8 ±3.9	115.3 ±5.6*	114.9 ±4.1*	116.3 ±4.1*	125.4 ±4.7
Osmolarity (mosm/kg H_2O)	252.5 ±9.4	283.5 ±8.3**	278.4 ±7.3**	264.5 ±6.2**	254.3 ±4.1

* – significant difference $P \leq 0.05$.
** – significant difference $P \leq 0.01$.

It has been known, that the action of glucocorticoids in relation to the blood electrolytes manifests itself only after few or several hours since their level increase (Bern 1975). It seems, therefore, that such rapid changes of the analyzed components, observed immediately after the completion of the fish transfer, must have been an outcome of the action of catecholamines. Adrenaline release is one of the primary stress responses (Schreck 1981) an it has been revealed that it stimulates electrolyte exchange in freshwater fishes (Richards et al. 1970).

On the other hand, the statistically significant changes in the concentrations of Na^+, K^+, Cl^- and in the osmolarity of the carp blood on the 1st and 4th day after the transportation and the change of environment, are the results of impact of glukocorticoids on regulation of hydro-mineral balance of the organism. The effect of the cortisol action was the most evident in the relation to sodium and potassium ions, causing statistically significant ($P<0.01$) increase in Na^+ concentrations and statistically significant fall in K^+ concentrations, accompanied by statistically significant decrease ($P<0.05$) in chloride-ion level. It has been assumed that the cortisol action lies in rising the activity of Na^+- and K^+-ATPase, accelerating ionic transportation, mainly Na^+ and Cl^- as well as water in the organs responsible for the regulation of hydro-mineral balance of fishes (Hirano 1978). It has been proven that in freshwater fishes it prevents losses of salts and diminishes Na^+ deficiencies in the blood serum (Fletcher 1975).

The presently conducted experiment revealed, that despite of the very high cortisol level persisting in the carp blood throughout the whole 7-day-long analyzed period, the levels of the studied electrolytes and the osmolarity returned back to normal. On the 7th day after the transport, the values of Na^+ and Cl^- concentrations as well as the osmolarity of carp blood, were similar to those observed before the experiment started.

It seems that the above-mentioned effect may be linked to the impact of glucocorticoids on the ECF (extracellular fluid) volume, through extrarenal pathway, on the ICF[1)] – ECF level (Kolpakov et al. 1969), as well as the changes inflicted thereof in the volume of serum (Swingle and Swingle 1966). It can be expected that the rise in blood serum volume, obscured to some extend, the parallel rise of the electrolytes content, and the above effect manifested itself only after the decrease of their concentrations per volume unit.

The exception were the potassium ions, whose concentrations on the 7th day of experiment were still statistically significantly ($P<0.01$) lower than the basic values, although statistically significantly ($P<0.01$) higher from those observed immediately after the transportation. The bibliography data, concerning the impact of glucocorticoids on the K^+ levels in the blood of fishes, are different form these shown in the present work. Kłyszejko (1986) concluded, that the temperature decrease in the water caused increase of K^+ levels in the blood of fish. Similarly Fletcher (1975) employing manipulation stress, observed its impact on K^+ rise. On the other hand Prosser et al. (1970) stated that the temperature rise from 15 to 25°C caused statistically significant decrease in the concentrations of potassium ions in the blood of goldfish. Variable effect of the glucocorticoids action on the level of potassium ions in the blood, is particularly evident in mammals. Friedrich (1993) stated that statistically significant cortisol rise in suckling calves did not caused any changes in the K^+ level. Kasperlik-Załuska et al. (1987) proved that state of hypercortisolemia in humans caused statistically significant drop in K^+ level. On the other hand Choroszewska and Misiewicz (1977) observed cortisol-inflicted increase of potassium ions in the blood of rats.

CONCLUSIONS

1. The transportation and the associated change of environment, causing statistically significant cortisol level rise, led to the increase of sodium- and chloride-ion concentrations and the osmolarity as well as to the fall of potassium-ion concentration in the blood of carp.
2. Despite the persistence of the high level of cortisol in the blood of carp, throughout the whole 7-day-long monitored period, the levels of Na^+, Cl^-, and the blood osmolarity came back to normal.

[1)] intracellular fluid

3. The exception were potassium ions, whose concentration on the 7th day after the transfer were still statistically lower than the initial values.

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STRESZCZENIE

Doświadczenie przeprowadzono na klinicznie zdrowych karpiach, w wieku +1, o masie ciała 610 ±70 g, pochodzących z hodowli w kanale wody pochłodniczej elektrowni Dolna Odra. Celem pracy było określenie wpływu transportu i uwalnianego pod jego wpływem kortyzolu na poziom elektrolitów i osmolarność krwi karpia oraz ocena czasu jaki musi upłynąć od przewozu ryb i zmiany środowiska, do powrotu analizowanych składników do stanu wyjściowego. Stwierdzono, że transport i zmiana środowiska, w wyniku których wystąpił statystycznie istotny wzrost poziomu kortyzolu, spowodowały wzrost stężenia jonów sodu i jonów chlorkowych oraz spadek stężenia jonów potasu we krwi karpi. Pomimo utrzymywania się wysokiego poziomu kortyzolu we krwi karpi przez cały analizowany okres, poziomy sodu, jonów chlorkowych i osmolarność krwi ulegały w tym czasie normalizacji. Wyjątek stanowiły jony potasu, którego stężenie w 7. dniu od transportu, ciągle jeszcze było statystycznie niższe od wartości podstawowych.

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