

Selected haematological and biochemical indices of the carp organism in ponds with a high production level*

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Abstract — During three different periods of the farming season the content of haemoglobin, haematocrit, proteins and total lipids of serum, the level of glucose, cholesterol, urea, creatinine, calcium, and inorganic phosphorus, and the activity of acid and alkaline phosphatase, and asparagine and alanine transaminase were investigated in the serum of one-year and two-year old carp under conditions of ponds with a high production level.

Key words: carp, ponds, intensive production, physiological indices.

1. Introduction

In investigating new methods of fish culture and intensification of production it is essential to evaluate the internal condition of the fish organism. With this aim the haematological indices and a number of biochemical components of the blood serum are determined or the activity of some enzymes is analysed. The indices are also used in ichthyopathological studies both for checking the pattern of changes accompanying different diseases or the intoxication of the fish organism, and for diagnostic purposes.

Because of the wide application of some haematological and bio-

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chemical indices in evaluating the effect of unfavourable environmental factors on the fish organism and state of health, it is necessary to determine the normal level of these parameters for the given species, age, and environmental conditions. Current information concerning the level of numerous physiological parameters in fish are only fragmentary. Some of the data available were obtained in investigations carried out outside the natural environment. Therefore, the aim of the present work was to determine the level of selected indices, most frequently used in pathophysiological investigations, in carp reared in ponds of relatively high production intensity. Apart from their cognitive character, the results of the study may be of some value in investigating the effect on the organism of carp of changes in factors of the environment brought about by the intensification of fish culture, and also in some ichthyopathological research projects carried out under natural conditions of production ponds.

Several physiological parameters were taken into consideration. They are widely used in observation of the physiological condition and health of endothermic animals and fish. The analysed indices characterize the blood, i.e., that component of the organism which unites all cells and organs in one functional unit.

2. Material and method

The analyses were carried out on second and third year carp, reared in ponds of the Gołysz Fish Culture Experimental Station. Second year fishes were examined in summer at a water temperature above 18°C, and in autumn when it fell below 15°C. Third year fishes were examined during three periods: in spring until the water temperature rose above 15°C, in summer during the period of intensive feeding at a water temperature above 18°C, and in autumn when the temperature fell below 15°C. Each time the catches were made at about 9–10 a.m., before the giving of feed. In the event of oxygen deficiency or disturbances in the health of the fish no catches were made.

The second year carp were caught in small experimental ponds of different intensification levels expressed by varying stock density: 6000, 24 000, and 60 000 per hectare. Third year carp were caught in a 1.1 ha pond stocked with 4500 specimens of this age group. The fish were fed with multicomponent pellets with a protein content varying from 25–40%. The ponds were fertilized with mineral phosphorus and nitrogen.

Blood samples were taken with a syringe from the caudal vein directly after the catch. The determinations included the concentration of haemoglobin, haematocrit, total protein, and lipids of the serum. The level of glucose, cholesterol, urea, creatinine, calcium, and inorganic phospho-

rus in the serum was determined and the activity of alkaline phosphatase (E.C.3.1.3.1.), acid phosphatase (E.C.3.1.3.2.), asparagine transaminase (E.C.2.6.1.1.), and alkaline transaminase (E.C.2.6.1.2.) measured. An attempt was also made to determine the activity of gamma-glutamyl-transpeptidase (E.C.2.3.2.1.). Haematological determinations were carried out using methods usually applied in examination of the blood in fish (Blaxhall, Daisley 1973, Kreuzmann 1974). The concentration of haemoglobin was determined by the cyanmethaemoglobin method using Drabkin's reagents. The level of the serum total protein was determined refractometrically. Total lipids were investigated using the Swahn method (1952). Other analyses were carried out with standard reagents produced by Lachema (Czechoslovakia), used in clinical diagnostics. All determinations were carried out simultaneously with the same blood sample. Their accuracy was checked by including human serum with determined components, Serostrand N, produced by the Serum and Vaccine Manufactories in Kraków.

The activity of enzymes was expressed in units (I.U.) denoting the number of micromoles of the substance (substrate) converted in the final yield of the reaction by 1 l of serum during 1 min at 37°C.

3. Results

Since the ichthyopathological examination did not show any distinct pathological symptoms at the same time of sampling, it was assumed that the health condition of fishes was normal. Hence, the obtained results can be regarded as typical for carp in ponds of an intensive production level.

The carp from different catches were characterized by a relatively great individual variability within most of the analysed indices. Considerable differences were observed among carp of similar weight and condition, in good health, and caught from the same environment, this suggesting a fairly wide range of the physiological norm for the particular parameters. The results, were therefore presented in the form of the arithmetical mean of those obtained in the given group of fishes investigated during the same period of the production season, and of the calculated range. In calculating the range of the particular indices, the value of the mean standard deviation (s) of results in the given group of specimens, calculated at (n) degrees of freedom, and the arithmetical mean (m) were used. Results varying within the interval ($m \pm s$) and including about 67% of those concerning the investigated population were conventionally assumed to be normal for carp in the given period of intensive farming (Table I).

In both age groups the least stable index was the level of glucose.

Table I. Arithmatic means and ranges (m ± s) of haematological and biochemical indices and activity of blood serum enzymes in second and third year carp from ponds with an intensive level of production tested in different periods of the rearing season

Age	Period of rearing season	Year	Number of fish	In Group	Haemoglobin g %	Haematocrit %	Serum total protein g %	Total Lipide mg %	Glucose mg %	Cholesterol mg %	Urea mg %	Creatinine mg %	Calcium mg %	Inorganic phosphorus mg %	Alkaline phosphatase I.U.	Acid phosphatase activity I.U.	Transaminase GOT activity I.U.	Transaminase GPT activity I.U.	
C ₁ /2	Summer	1977	40	7.08 5.9-8.3	33.6 30-38	3.32 2.8-3.9	659.6 411-908	81.8 48-115	126.9 108-168	14.26 11.4-17.2	0.32 0.2-0.4				41.0 20-61	8.2 4-12	37.9 30-45	26.3 10-42	
		1978	20	7.53 6.9-8.1	39.8 36-44	3.32 2.9-3.7	603.6 480-727	82.0 53-111	110.8 91-131	19.87 13.8-25.9	0.36 0.3-0.4	7.25 6.8-7.7	10.12 8.5-11.7		52.3 28-76		45.7 35-56	35.1 22-48	
		1979	40	5.22 4.2-7.2	22.6 21-27	3.40 2.8-4.0	741.0 583-899	67.2 39-95	142.2 112-172	15.97 11.9-20.1	0.37 0.3-0.4	8.13 7.2-9.1	34.8 16-53		24.8 16-53	8.9 6-12	36.0 26-46	34.4 21-47	
	Autumn	1977	25	7.65 6.4-8.8	34.8 30-40	3.12 2.8-3.4	596.6 486-707	75.5 47-104	151.0 128-176	13.16 12.1-14.2	0.45 0.3-0.6	6.31 5.4-7.2	10.79 7.8-13.8		47.2 33-61	6.0 4-8	47.0 29-65	20.2 14-26	
		1978	40	6.55 5.8-7.3	32.1 28-36	3.84 3.3-4.4	640.1 412-868	34.6 27-42	153.4 120-187	16.54 14.2-18.9	0.26 0.1-0.4	5.31 4.2-6.4	8.50 7.2-9.8		65.0 38-92		33.7 25-43	32.1 24-40	
		1979	40	6.70 5.2-8.2	31.7 25-38	3.22 2.6-3.8	360.8 246-476	73.4 14-133	135.4 108-163	11.26 7.2-15.3	0.43 0.3-0.6	7.58 6.5-8.7	29.2 18-42		29.2 18-42	7.6 6-9	31.2 24-39	36.7 26-48	
	C ₂ /3	Spring	1978	20	6.95 5.8-8.1	30.6 27-34	2.25 1.8-2.6	390.0 245-535	64.4 46-83	114.5 92-137	9.98 7.2-12.8	0.29 0.2-0.4	7.24 6.3-8.1	9.20 7.8-10.6		33.8 20-47	4.0 3-5	54.9 43-67	12.1 11-13
			1979	40	7.68 6.3-9.0	32.1 28-36	3.38 2.8-4.0	546.0 429-663	68.7 48-89	148.9 121-177	10.73 8.5-12.9	0.40 0.3-0.5	7.36 6.2-8.5	6.56 5.3-7.9		33.5 15-52	3.7 3-5	46.8 37-57	15.3 8-22
			1977	5	7.20 6.4-8.0	39.2 34-45	3.26 2.8-3.8	737.0 590-884	92.2 75-109	132.8 105-160	19.37 15.0-23.8	0.45 0.4-0.5				42.8 34-51	12.5 10-15	37.2 30-45	24.9 23-27
		Summer	1978	20	6.60 5.8-7.4	36.3 31-41	2.88 2.6-3.2	477.1 364-590	96.4 68-124	118.3 96-140	19.84 17.0-22.7	0.24 0.2-0.3	3.46 2.4-4.6	14.38 12.0-16.8		43.2 29-58	8.1 6-10	34.1 25-43	15.7 10-22
1979			40	6.30 5.5-7.1	34.2 29-40	3.05 2.5-3.6	847.1 707-987	80.8 45-116	109.3 90-128	13.95 11.9-16.0	0.45 0.3-0.6	8.90 7.0-10.8	43.4 15-71		43.4 15-71	10.8 8-14	34.6 24-48	19.4 13-25	
1977			10	8.64 7.0-10.3	38.8 33-44	3.14 2.9-3.4	376.7 323-430	70.4 58-83	100.5 86-112	15.96 12.7-19.1	0.36 0.3-0.4	7.07 5.9-8.3	11.36 9.2-13.5		7.3 5-9	23.6 17-30	5.1 4-7		
Autumn		1978	25	8.31 7.9-9.3	38.6 35-42	3.41 3.0-3.8	586.7 374-800	50.2 35-65	128.9 113-144	14.88 11.9-17.8	0.38 0.3-0.5	6.10 4.2-8.0	9.51 8.3-10.7		30.2 15-45		29.2 16-42	116.1 10-23	
		1979	10	7.21 6.3-8.2	10.4 27-33	3.42 3.2-3.6	254.3 209-299	35.8 32-39	145.3 130-161	7.76 6.4-9.1	0.30 0.2-0.4	7.45 6.9-8.0	45.1 10-71		45.1 10-71				

Sometimes within one catch the results varied from 20—120 mg% glucose. Small individual differences were observed in the level of creatinine and in the activity of alkaline phosphatase. In second and third year fishes most parameters were different. Differences were also observed between various periods of the farming season (Table I). With low values of haemoglobin concentration during the season, this parameter reached a level of over 8 g% in specimens examined in autumn (particularly third year ones). Similarly, the highest values of protein in the serum (up to 3.8 g%) were noted in autumn while the highest level of total lipids (up to 900 mg%) occurred in summer. In the remaining parameters less distinct differences were found.

An attempt at determination of gamma-glutamylotranspeptidase activity in the serum using gamma-L-glutamyl-p-nitro-anilide as substrate, gave a negative result, probably because of the method used. It is also possible that this enzyme does not occur in carp.

4. Discussion

Indices of different type characterizing the internal environment of the fish organism have been investigated for many years. Attempts were made to use them in controlling the pattern of normal physiological indices (Field et al. 1943, Antipova 1954, Lacombe, Creach 1974, Meunier 1978), changes accompanying disease (Svobodová, Tesarčík 1974, Jeney et al. 1981), and external effects (Körting 1969, Litzbarski 1974). For example, the level of selected physiological parameters in fish was checked by testing a number of factors associated with intensification of carp production, such as various types of feed, density of fish in the water body, or some elements of the environment altered by the intensification (Striebková 1968, Sadychov, Pietienko 1969, Svobodová, Havelka 1977, Smeda, Houston 1979). In the studies mentioned above basic haematological indices were most frequently used, particularly those characterizing the red blood picture, concentration and composition of serum proteins, and, more rarely, the number and composition of leucocytes. The present work should be a supplement to the problem, since it provides results concerning a certain number of physiological indices of carp reared in ponds. The fishes were affected by a complex of external factors associated with the intensification: population density, the predominating role of multicomponent pellets in feeding, a decisive increase in the content of nitrogen and phosphorus compounds and mineral and organic suspension in the water, oxygen deficiency, and variation in the reaction of the water.

The obtained results are in accordance with earlier data (Antipova

va 1954, Kudriacev et al. 1969). This confirms the stability of the internal environment of the carp organism in spite of changes in the living conditions of fish in ponds with a high production level. The values of red blood indices were found to be below the level given in the literature for carp (haemoglobin concentration 6—7 g⁰%, haematocrit 29—34⁰% and correspondingly 8—9 g⁰% and 34—40⁰% (Kudriacev et al. 1969). The level of glucose, total serum protein, and urea was higher than that given in the literature, while the content of calcium and inorganic phosphorus was maintained below the expected values (Table I).

Comparison of the collected material with available data concerning the level of the investigated parameters suggests that the deviations observed were brought about by intensive fish culture. However, no decisive disturbances of the equilibrium in the internal environment of the fish organism were observed. The table gives the results of determination of physiological parameters of carp which seem to be characteristic for this species reared in ponds of intensive fish production.

5. Polish summary

Wybrane wskaźniki hematologiczne i biochemiczne organizmu karpi w stawach o wysokim poziomie intensyfikacji produkcji

Szerokie wykorzystanie wskaźników hematologicznych i biochemicznych w badaniach wpływu na organizm ryb niekorzystnych czynników zewnętrznych oraz do oceny stanu zdrowotnego, wymaga ustalenia normalnego poziomu uwzględnionych parametrów dla określonego gatunku ryb, wieku i warunków środowiskowych. Za cel prezentowanej pracy przyjęto określenie poziomu kilkunastu wskaźników fizjologicznych dla karpi hodowanych w stawach o stosunkowo wysokim poziomie intensyfikacji produkcji. Wykonano analizy u karpi w drugim roku życia, hodowanych w zagęszczeniach 6000, 24 000 i 60 000 sztuk narybku na hektar oraz karpi w trzecim roku życia z obsady 4500 sztuk krocza na hektar. Badania koncentrowano w 2—3 okresach sezonu hodowlanego. Prezentowane w tabeli I wyniki oznaczeń wybranych parametrów fizjologicznych organizmu karpi uznać można za charakterystyczne dla tego gatunku hodowanego w stawach metodą intensywną.

6. References

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