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Fish Culture

INFLUENCE OF STOCK DENSITY AND FOOD USED ON GROWTH OF CARP KEPT IN COOLING WATERS

WPŁYW WIELKOŚCI OBSAD I STOSOWANYCH PASZ NA WZROST KARPI (K_{2-3}) W WODZIE POCHŁODNICZEJ

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The paper describes studies on influence of various stock densities and foods differing in their chemical composition upon growth of fishes kept in cages placed in the Dolna Odra power station cooling waters.

INTRODUCTION

In view of an urgent need to increase the freshwater fish production for the domestic market, the attention has been drawn in recent years to the problem of the cooling waters utilisation in fish cultures.

The perspectives of producing marketable fish, carp in particular, in those waters are considerable. According to Bogdanova (1976), the utilisation of the Kiriska power station cooling waters to carp rearing allows to obtain 2500 t of marketable fish over a year. Iskov (1977) estimates the present potential of commercial fish rearing in Soviet warm waters at 100 000 t a year.

The favourable thermal conditions for rearing thermophilic fish in cooling waters permit to obtain the effects unheard of in the classic carp cultures. The studies described by Titareva (1974) indicate 100–200 kg/m^3 as a result possible to obtain; similar results (175 kg/m^3) were obtained by the research team guided by Trzebiatowski et al. (1976).

In recent years, many countries' (USSR, GDR) studies on fish rearing in heated waters have been focused mainly on a rational and economic fish feeding on quality granulated foodstuffs. The results reported by Timosina (1976) and Strelcova et al. (1972) indicate to possiblities of obtaining, in feeding carp, relatively lov feeding coefficients (2.3–3.8) with a simultaneous utilisation of low-protein (26.5%) food.

Within the framework of studies on the utilisation of cooling waters in fish rearing, experiments with rearing carp in the Dolna Odra power station cooling canal were continued. The basic aim was set at following the influence of various stock densities and of offering to fish various diets differing in their protein content upon growth and output of the cultures.

MATERIAL AND METHOD

The experiments were run in the Dolna Odra power station cooling canal. The experimental conditions and technical lay-out of the experiment are described in one of the previous papers by the authors (Trzebiatowski et al., 1976). To rule out a possible escape of fishes due to a damage in the netting, the cages were placed in 20 mm mesh wire net cases. Each cage contained 3 m^3 of water.

Four variants of the experiments, three replicates each, were run (Table 1).

Table 1

The eksperimental design

Variant	Stock		Food
	ind./m^3	ind./cage	
I	100	300	Carp granulate
II	140	420	,, ,,
III	180	540	,, ,,
IV	100	300	PP "Grower"

The experimental material consisted of 3780 juvenile carp individuals brought on May 19, 1976 from the Lipiany Fish Farm. The fishes were in a good condition and healthy.

The stocks varied from one experimental variants to another (Table 1). The fishes were given two kinds of food: a PP "Grower" granulated blend for piglings, produced by "Bacutil", Stargard and a granulate for carp, produced by the Słupsk Fish Farm (Table 1). The chemical composition of various foods was diverse (Table 2).

The granule diameter in both types of food was 4.8 mm. The fishes were fed every day except Sundays, 6–8 times a day at 1–1.5 hr intervals. A daily portion was 3, 6, and 3% of fish weight in May 5 – July 22, July 23 – September 22 and September 23 –

Table 2

Percentage chemical composition of carp food

Component determined	PP „Grower"	Carp granulate
Raw protein	16.9	31.7
Raw fat	3.3	8.1
Carbohydrates	63.8	43.2
Ash	4.6	8.7
Water	11.4	8.3

October 15, respectively. Twice a week the Polfamix C vitamine mix (1% of daily food portion) was added to the food.

DISCUSSION OF THE RESULTS

Physico-chemical conditions in water during the period of the experiment

The results of physico-chemical analyses of water are presented on graphs as weekly means and their ranges. All the analyses were performed daily (except Sundays), in the afternoon.

Weekly temperature means and their ranges of variation, presented in Fig. 1, were calculated from recordings of a thermograph mounted on the platform. The data show the temperature weekly changes to ragne within 19.6–30.6°C, 14.8 and 32.0°C being the extremal values. Maximum daily amplitudes reached 8.6°C.

The mean oxygen saturation changed from 119% in the first few weeks to 71% in the final period of the experiment (Fig. 2). This factor changed but a little from week to week. A significant decrease in the oxygen saturation of cooling waters was recorded only in late September when it dropped to 43% at the beginning of the week to rise subsequently to 92.5% towards the end of the week. The causes of so great a change in the water oxygenation are difficult to determine due to the lack of any full-scale hydrochemical analyses program. It can be only supposed that a load of effluents containing strongly oxygen-absorbing compounds was released into the canal at that time.

The water pH range was relatively narrow – 6.2 to 7.9 (Fig. 3).

Effects of fish culturing and feeding

The experiment was run over 148 days (May 5 – October 15, 1976); the fishes were fed during 112 days. Control weighings were performed every third week. Usually the experimental variants yielded different results.

In the variant I, the fishes increased their individual weight 3.2 times, the mean daily growth being 0.93%. A mean daily output was 10.4 kg/m^3, 36.4 kg being the original weight. Losses due to mortality amounted to 13 individuals, i.e., 4.3%.

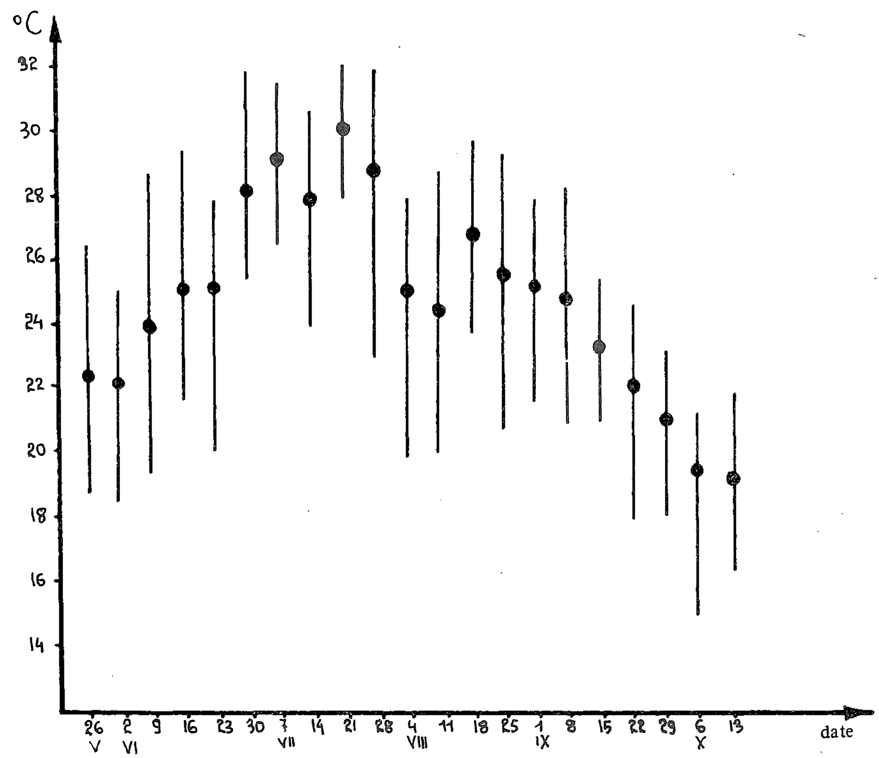

Fig. 1. Mean weekly values and ranges of water temperature in cooling canal.

The variant II produced similar results, the mean individual weight rising 3 times and mean daily growth amounting to 0,90%. Losses due to mortality were lower and amounted to 1.7% of the stock only (7 individuals). The output and original weight were 140.6 kg/m^3 and 46.7 kg, respectively.

In the variant III which had the largest stock the mean individual weight of carp increased 2.8 times only. Also the lowest mean daily growth of 0.83% was obtained. In spite of a considerable density of the stock in cages, the mortality rate was low, the losses amounting to 1.3% of the stock. A highest output of 170.9 kg/m^3 from the original stock of 62.4 kg was harvested in this variant.

In the variant IV, when the fishes were fed with the "Grower", their mean individual weight increase was similar to that obtained in the variant III (2.8 times). The mean output was 34.7 kg/m^3 from the original stock of 95.9 kg; the daily individual growth reached 0.85%. The losses were small (6 individuals, i.e., 2.0% of the stock).

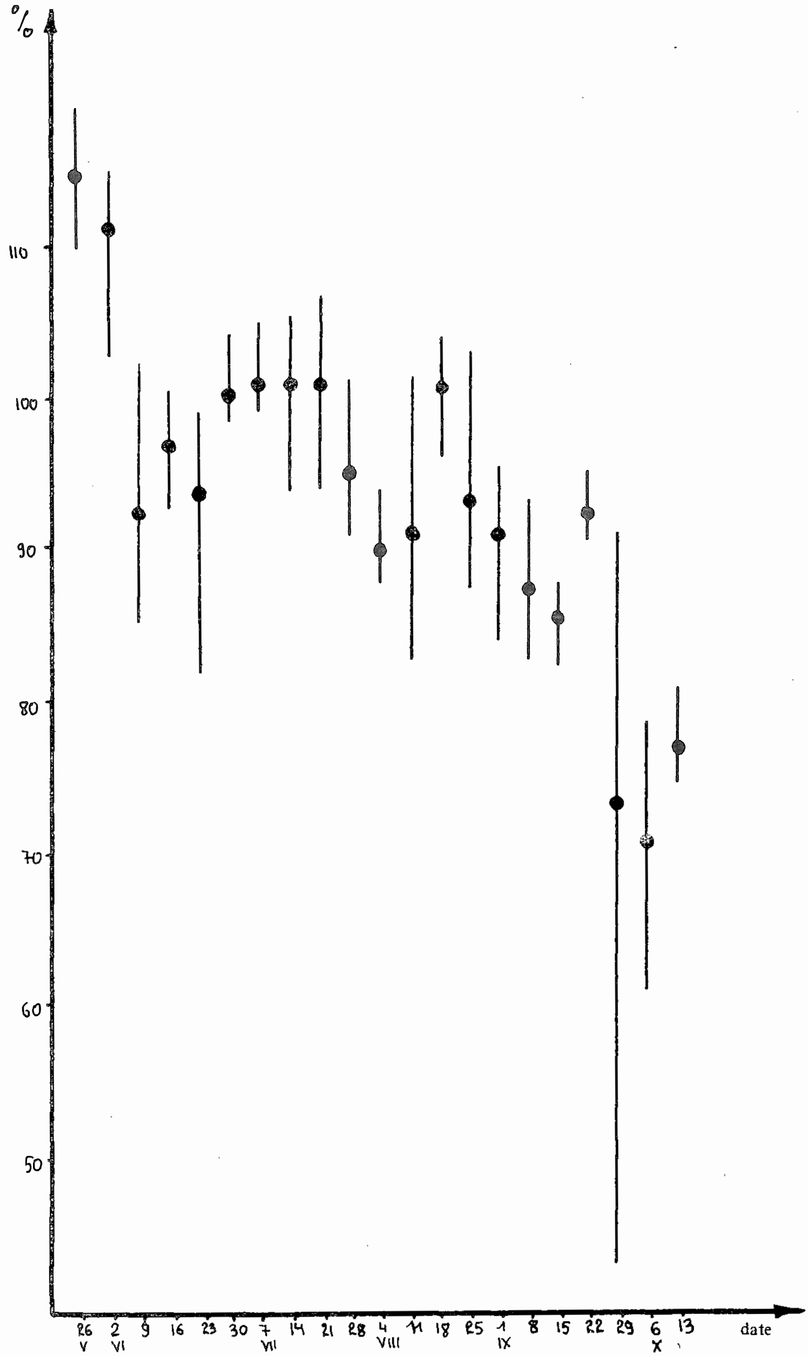

Fig. 2. Mean weekly values and ranges of water oxygen saturation in cooling canal

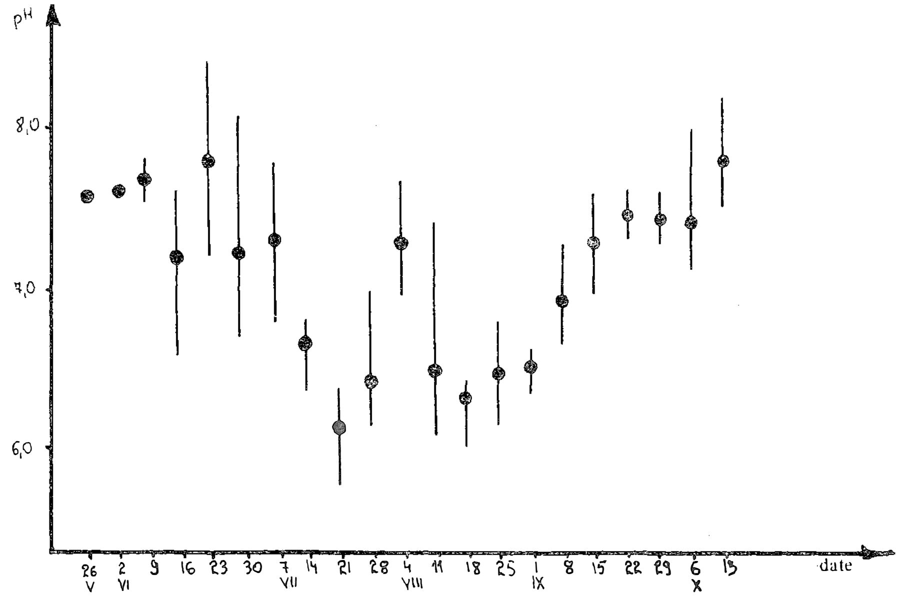

Fig. 3. Mean weekly values and ranges of water pH in cooling canal.

The fish growth rate changed considerably, ranging, on the average, from 10 to 35% in different variants of the experiment (Fig. 4). At the beginning, the growth was even null in the variant III due to a low feeding activity of fishes, which was presumably caused by septicaemia affecting almost every individual. The disease spread was stopped after

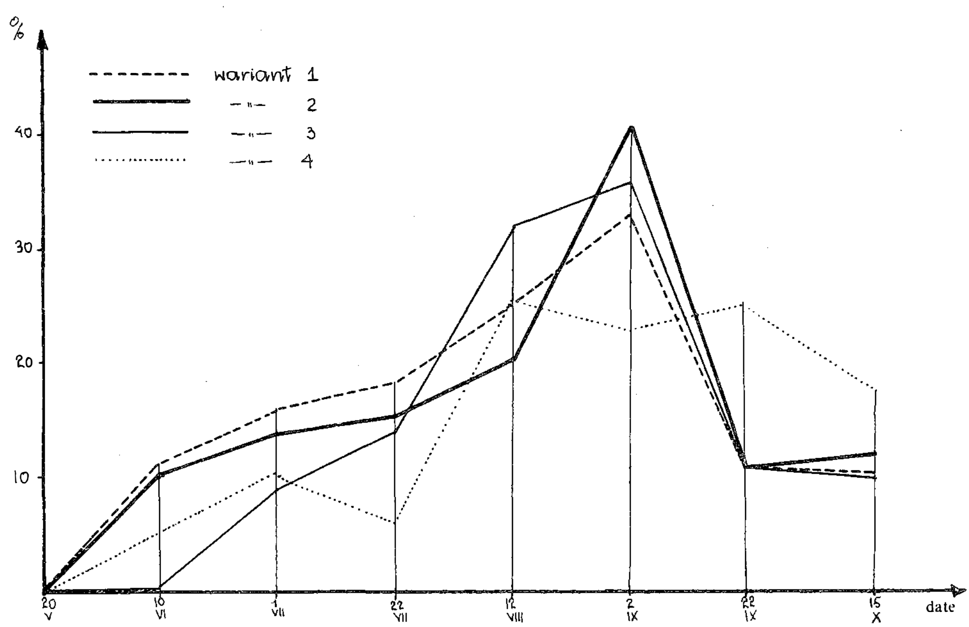

Fig. 4. Experimental carp growth rate (C_{2-3}).

Table 3

Result of experimental rearing of carp (C_{2-3})

Variant	Stock ind./cage*		Total weight	Weight growth	Mean ind. weight	Mean ind. weight growth		Food used	Feeding coeffi-cient	Losses in stock		No of days of feeding
	start	end	kg/cage*	kg/cage*	g	g	%	kg/cage*		ind.	%	
I	300	287	331.4	222.2	1154.7	790.7	317.2	736.49	3.31	13	4.3	112
II	420	413	421.8	281.7	1021.3	687.7	306.1	930.53	3.30	7	1.7	112
III	540	533	512.7	328.7	961.9	614.9	277.2	1135.78	3.45	7	1.3	112
IV	300	294	287.8	183.5	987.9	631.9	282.1	614.10	3.35	6	2.0	112

* cage working capacity of 3 m^3 of water

2–3 weeks by increasing the food vitamine content to 2%. Mortality was low in this starting period, only 24 individuals being lost. A steady increase in the water temperature promoted a fast growth of the fishes. Over the period from the last decade of July till the first decade of September, the growth rate increased markedly (to 35% in August), which resulted from a daily food partion increase from 3 to 6% on one hand, and from an increase in the mean water temperature to 25–30°C on the other. Over that period, the water was well-oxygenated (90–100% saturation).

At the final stage of the experiment, in view of a decrease in the water temperature below 24°C and a poor feeding activity, it was found necessary to reduce the daily food portion to 3%, which was accompanied by a fall in the fish growth rate to 12% on the average and to 17% in the variant IV.

Another factor that was presumably responsible for the decrease in fish growth was the food granule diameter. Too fine a food (4.8 mm) in relation to fish size as well as a substantial amount of fishes in the cages (to 400 kg) resulted in the fishes throwing a part of their food beyond the cage walls during intensive feeding. Because of that reason too, feeding coefficients increased at that time to 3–4 and more. The average individual weights obtained in the course of the experiment point out that carp grew best in the variant I, i.e., at the stock density of 100 ind./m^3, the lowest individual growth being obtained in the variant III, with the cages being most densely stocked (180 ind./m^3, Table 3).

A comparison of various granulated foodstuffs used for feeding carp confirmed an earlier presumption of a somewhat lower quality of the "Grower". It was confirmed by different mean individual growths amounting to 978.9 g for fish kept on the "Grower" as opposed to 1154.7 g obtained when feeding the carp granulate, the mean original weights of the two batches being 347.3 and 364.0 g, respectively (Fig. 5). When one, however,

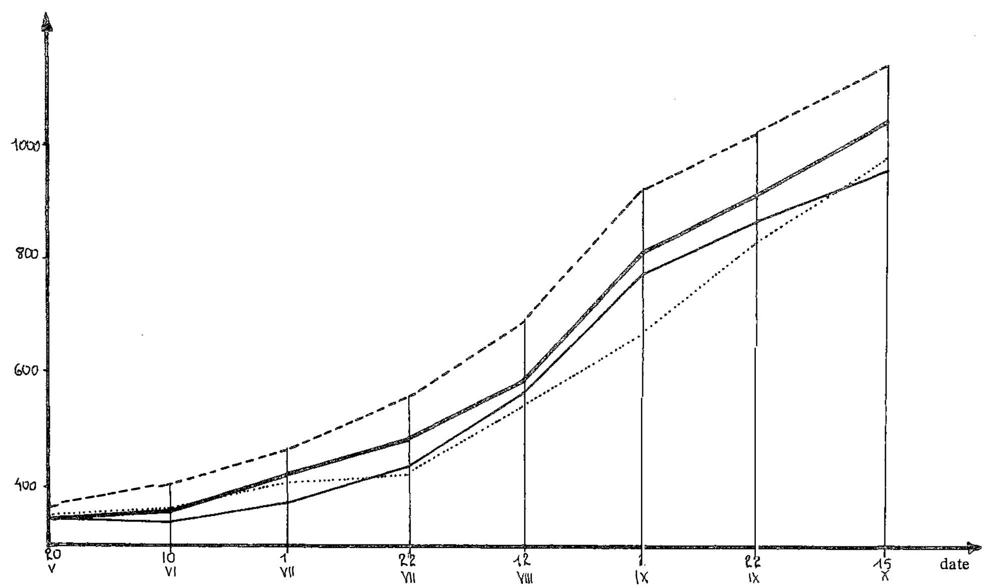

Fig. 5. Mean individual weight growth of carp (C_{2-3}) in various experimental variants

considers the fact that the "Grower" and the carp granulate contained 16.9 and 31.7% of total protein, respectively, the difference between the mean individual weights of 176.2 g (18%) does not seem too large. The feeding coefficient obtained when using the "Grower", 3.35, was almost identical with that for the carp granulate (3.31).

Chemical analyses of fish bodies performed after the completion of the experiment showed the "Grower" – fed carp to contain 16.8% of total protein and 6.5% of fat, while the granulate-fed carp kept at the same stock density showed the respective protein and fat contents of 18.8 and 6.2%. In the fishes kept at a density of 140 ind./m^3, the analyses showed clearly lower contents of the components analysed: 18.0% of total protein and 4.0% of fat. The data referred to indicate the stock density of affect the fish body chemical composition in a slight way as opposed to the quality of food offered, particularly with respect to the total protein content (Table 4).

Table 4

Percentage contents of selected components in experimental fish flesh (percentage)

Chemical composition of fish flesh \ Experimental variant	I	II	IV
Raw protein (Kjeldahl metod)	18.8	18.0	16.8
Fat (Soxhlet method)	6.2	4.0	6.5
Water (drying at 105° C)	77.4	78.4	77.4

CONCLUSIONS

1. Optimal stock densities for cage-rearing carp (C_{2-3}) in cooling waters range within 100–140 ind./m^3.
2. A granule diameter of the granulated food should be gradually increased with fish growth, which is one of the prerequisites for an economical utilisation of fish food.
3. In an intensive rearing of carp in cooling waters, it is possible to use foods of ca 20% protein content. This indicates a possibility to manufacture much cheaper foods and to utilise their protein content in a much more economical way.

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WPŁYW WIELKOŚCI OBSAD I STOSOWANYCH PASZ NA WZROST KARPI (K_{2-3}) W WODZIE POCHŁODNICZEJ

Streszczenie

Założeniem pracy było zbadanie wpływu różnych gęstości obsad oraz żywienia karpi (K_{2-3}) paszami o zróżnicowanej zawartości białka na wzrost i efektywność ich chowu. Doświadczenie zostało przeprowadzone w okresie od 19.05. do 15.10.1976 r. W trzech pierwszych wariantach doświadczenia (I–III), przy obsadach (odpowiednio) 100, 140, 180 szt/m^3 wody ryby żywiono granulatem o zawartości 31,7% białka ogólnego, w wariancie IV zaś, przy obsadzie 100 szt/m^3 wody ryby żywiono granulatem o zawartości 16,9% białka ogólnego.

Średnie tygodniowe wartości trzech najważniejszych czynników fizykochemicznych wody w czasie doświadczenia kształtowały się następująco: temperatura 19,6–30,6°C, nasycenie tlenem 71–119% i pH 6,2–7,9.

W poszczególnych wariantach doświadczenia wartości współczynników pokarmowych i wielokrotność średnich przyrostów jednostkowych masy odpowiednio wynosiła: I–3,35 i 3,3; II–3,30 i 30; III–3,46 i 28; IV–3,35 i 2,8. W wariancie z największą obsadą (III) wydajność z 1 m^3 wody wyniosła 170,9 kg ryby.

Z pracy wynika, że najbardziej optymalne pod względem liczbowym obsady karpi (K_{2-3}) przy sadzowym ich wychowie w wodzie pochłodniczej powinny mieścić się w granicach 120–140 szt/m^3 wody. Jednocześnie wykazano, że intensywny chów karpi może być prowadzony przy stosowaniu pasz granulowanych o zawartości białka ogólnego ca 20%.

Р. Тшебятовски

ВЛИЯНИЕ ПЛОТНОСТИ ПОСАДКИ И ПРИМЕНЯЕМОГО КОРМА НА РОСТ КАРПА ($К_{2-3}$) В ОТРАБОТАННОЙ ОХЛАЖДАЮЩЕЙ ВОДЕ

Р е з ю м е

Целью работы было изучение влияния различной плотности посадки и кормления карпа ($К_{2-3}$) кормом с разным содержанием белка на рост и эффективность его выращивания. Эксперимент был проведен в период с 19.05. до 15.10.1976 г.

В первых трёх вариантах опыта (I-III) при плотности посадки соответственно 100, 140 и 180 шт/м^3 воды рыбу кормили гранулированным кормом с содержанием 31,7% общего белка, в IV же варианте при плотности посадки 100 шт /м^3 воды рыбу кормили гранулированным кормом с содержанием 16,9% общего белка.

Средненедельные величины трёх важнейших физико-химических факторов воды во время эксперимента представлялись следующим образом: температура 19,6-30,6°C, насыщение кислородом 71-119% и pH 6,2-7,9.

В отдельных вариантах опыта величина кормовых коэффициентов и многократность средних удельных приростов массы составляла соответственно: I-3,35 и 3,30; II - 3,30 и 3,00; III - 3,46 и 2,80; IV - 3,35 и 2,80.

В варианте с наибольшей плотностью посадки (III) выход с 1 м^3 составил 170,9 кг рыбы.

Из работы следует, что наиболее оптимальные с количественной точки зрения плотности посадки карпа (K_{2-3}) при выращивании его в садках с отработанной охлаждющей водой должны быть в границах от 120 до 140 шт/м^3 воды. Одновременно доказано, что интенсивное выращивание карпа можно проводить с применением гранулированного корма с содержанием общего белка около 20%.

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