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Fish culture

THE EFFECT OF FEEDING CARP (*CYPRINUS CARPIO* L.) FRY WITH PELLETS OF VARYING PROTEIN CONTENT

WPŁYW KARMIENIA PASZĄ GRANULOWANĄ O RÓŻNEJ ZAWARTOŚCI BIAŁKA NA CECHY UŻYTKOWE KARPIA (*CYPRINUS CARPIO* L.)

The influence of pellets containing 10%, 20%, 30% and 40% protein content on morphometric parameters of carp fry was investigated. A highly significant correlation between protein content and increase in body weight, head weight, body length was foundm A significant correlation was recorded for weight of trunk and entrails, length of head and intestine, body thickness and maximum body height. No significant correlation was found for the Fulton nutrition factor, the dorsal index (according to Kiselev), body circumference, percentage of protein and fat in flesh.

INTRODUCTION

Protein content of feed appears to be the most important factor to increase production in carp (*Cyprinus carpio* L.) breeding. Most investigations in this field have been carried out on fry aged 1 and 2. Haner (1982) stated the significance (F-test) of the effect of the frequency of feeding carp fry of ca. 50 g with pellets containing 31% protein. Hepher et al. (1965) investigated the effect on carp fry when feeding with pellets of 28–30% protein content, depending on differences in fertilization and stock. They found that the use of pellets increased the pond yield, but only above a certain "critical" stock density depending on the amount of natural food present. Koch (1976), stated that, assuming losses of about 30%, the number of age – 1 fish obtainable from ponds can be 25 000 – 30 000 per hectare when the fry is additionally fed with pellets containing 17–22% protein. Lieder (1965) has shown that pellets may be used to feed carp even at the age – 0 (1 g body weight); however a high mortality rate was noted.

The study was carried out at the Experimental Pisciculture Station of the Polish Academy of Sciences, Golysz, during the period September 1984 – March 1985

The best results were achieved by commencing pellet feeding when the fish were not less than 2.5 g in weight. Marek (1975) investigating the dependence of protein content of fish on the protein content of pellets, found that an increase of 1 g in body weight required the consumption of 2.4 g of feed with a protein content of 25%. According to Steffens (1979), carp showed optimum growth when the feed contained about 40% protein.

The present study aims to determine the influence of pellets of varying protein content on the morphometric parameters (which has probably not been carried out yet), body protein and fat content of carp fry aged – 0–1.

MATERIAL AND CONDITIONS OF EXPERIMENTS

Investigations were carried out at the Experimental Pisciculture Station of the Polish Academy of Sciences, Golysz, between May and October, 1984. Carp aged – 0 (body weight 1–1.2) g) from the station's hatchery was used.

The experiments were carried out in 12 ponds, each 0.15 ha in area and 1.5 m in depth, supplied with Vistula river water. Stocking density was 90 000 fry/ha. The fry remained in the ponds throughout the growing season. All ponds were fertilized to the same extent with ammonium nitrate, superphosphate and liquid manure (Table 1). The fish were divided into four experimental groups: I–IV, fed with pellets of 10%, 20%, 30% and 40% protein content, respectively.

During 33 days from hatching the fry grew on natural food and reached weights of 1.1–2.0 g. Pellets were then given as follows: 3 times in June, 22 times in July, 18 times

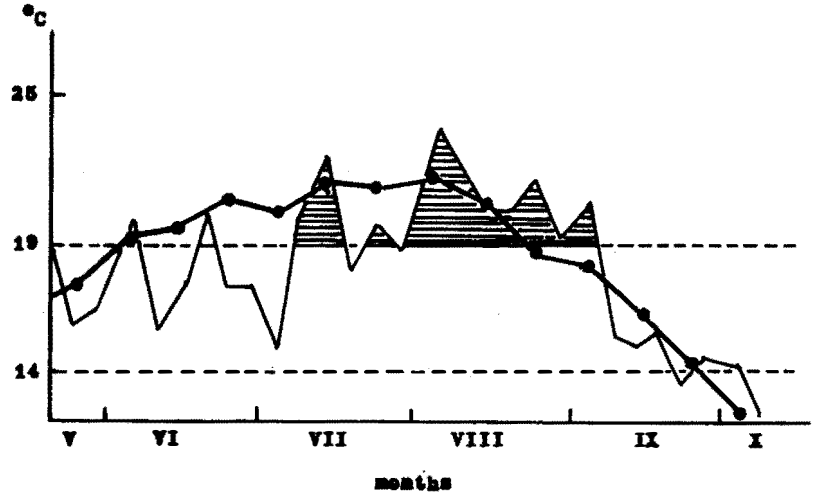

Fig. 1. The temperature of water in experimental ponds in 1984.
Thin line – pentad averages, thick line – multiannual average

Table 1

Characteristics of experimental ponds: 0 – comparatively unfertilized group, NP – group fertilized with mineral fertilizers, G – group fertilized with organic fertilizers, M – group fertilized with mineral and organic fertilizers

No of pond	Pellet		Fertilization			Fertiliz. in 1983 0, NP,G,M
	% of protein	kg	ammonium nitr.	super-phosph.	liquid manure	
1	10	584	85	60	600	O
7		869				M
9		814				G
4	20	859	85	60	600	O
8		849				M
12		269				G
5	30	869	85	60	600	O
6		889				NP
11		804				M
2	40	889	85	60	600	G
3		889				NP
10		759				NP

Data relating to the division of the ponds into four experimental groups, the quantity of feed used per pond and the fertilization of ponds during the experimental and during a one year period prior to the experiment.

Table 2

The composition of pellets

Components \ % of protein	10	20	30	40
Wheat flour	97%	70%	45%	21%
Fish meal		10%	23%	35%
Soy cake (degreased and ground)		5%	10%	15%
Milk powder (degreased)		5%	3%	4%
Dry fodder yeast		2%	10%	15%
Egg mass (duck eggs)		5%	6%	7%
Vitamin mixture	1%	1%	1%	1%
Mineral mixture	2%	2%	2%	2%
kg	250	250	250	250
%	100	100	100	100

For the composition of mineral mixture and vitamin mixture see Table 3 and 4, respectively

in August and 13 times in September. The composition of pellets, of mineral mixture and of vitamin mixture are shown in Table 2, 3 and 4.

In 1984 water temperatures were relatively low (Fig. 1) as the season was rather cold. During the summer months the water temperature (pentade averages) was lower than the annual average over the period 1956–1981.

During the experiment 8 control catches were taken; 30 fish were caught at random from each pond to establish increase in body weight. 10 of the 30 were the subject of morphometric measurements and 5 were investigated to determine flesh protein and fat content. The following measurements were made:

a. Nutrition factor – The amount of consumed food per 1 kg increase in fish weight.

b. Condition factors:

- Fulton factor – $\frac{100 \times W}{L^3}$
- dorsal index – $\frac{L}{H}$
- circumference index – $\frac{L}{C}$

where:
W = body weight in g, L = body length in cm, H = maximum body height in cm, C = body circumference in cm.

c. 11 morphometric features:
weight (g) of body, trunk, head and entrails, body length, length of head, length of intestine, body thickness, maximum body height, body circumference, total body length (cm). Weight was measured with an accuracy to 1 g (± 0.1 g), while all other measurements were made with an accuracy of 0.1 cm.

d. Percentage of protein in flesh – Kjeldahl's method was used according to Budslawski and Drabent (1972).

e. Percentage of fat in flesh – Gerber's method was used according to Budslawski and Drabent (1972).

After the measurements had been made, the arithmetical means, standard deviations and F-test at $P < 0.05$ according to Ruszczyc (1978) were calculated.

Similar survival rate values were taken as the criterion of similar experimental conditions; thus, morphometric and biological measurements were based on the data obtained from ponds showing a survival rate of 61.6–67.6%, (ponds No. 7,4,6 and 3 representing the four experimental groups).

The final data on catches shown in Table 5 are based on the author's own research and also on those carried out by the Experimental Station and made avaible to him.

Table 3

Composition of the mineral mixture

Name	Amount in %
Fodder phosphates	63.0
Fodder chalk	12.02
Fodder salt	16.0
Sodium sulfate (Na_2SO_4)	6.0
Magnesium sulfate ($MgSO_4$)	2.0
Iron sulfate ($FeSO_4$)	0.3
Copper sulfate ($CuSO_4$)	0.1
Ammonium carbonate $(NH_4)_2CO_3$	0.04
Cobalt sulfate ($CoSO_4$)	0.02
Zinc sulfate ($ZnSO_4$)	0.5
Potassium iodide (KJ)	0.02
Σ	100.00

(See Table 2)

Table 4

Composition of the vitamin mixture "Premix"

Name	Amount in g
Vitamin A	800.000 i. unit.
Vitamin D_3	200.000 "
Vitamin F	10.0
Vitamin B_6	0.6
Vitamin B_1	2.0
Vitamin B_2	3.0
Vitamin C	30.0
Vitamin K (Kavitan)	0.3
Lime panthotenate	10.0
Folic acid	0.4
Biotine	0.02
Inositol	30.0
Choline chloride	200.0
Nicotinic acid	3.0
Methionine	30.0
Lisine	80.0
Niacin	3.0
P-aminobenzene acid	0.06
Wheat flour	to 1000.00

(See Table 2)

RESULTS

After about 1 month the stock reached the K_v stage (about 5 cm in length and 2 g in weight). After four more months average catches ranged from 37 277 to 53 061 fish/ha, with a weight range of 28.33–50.00 g and length range 10–12 cm (stage of age – 1) (Table 5). It was found that regardless of the type of feed used, the fish survival rate varied from 35.1 to 66.4% (Table).

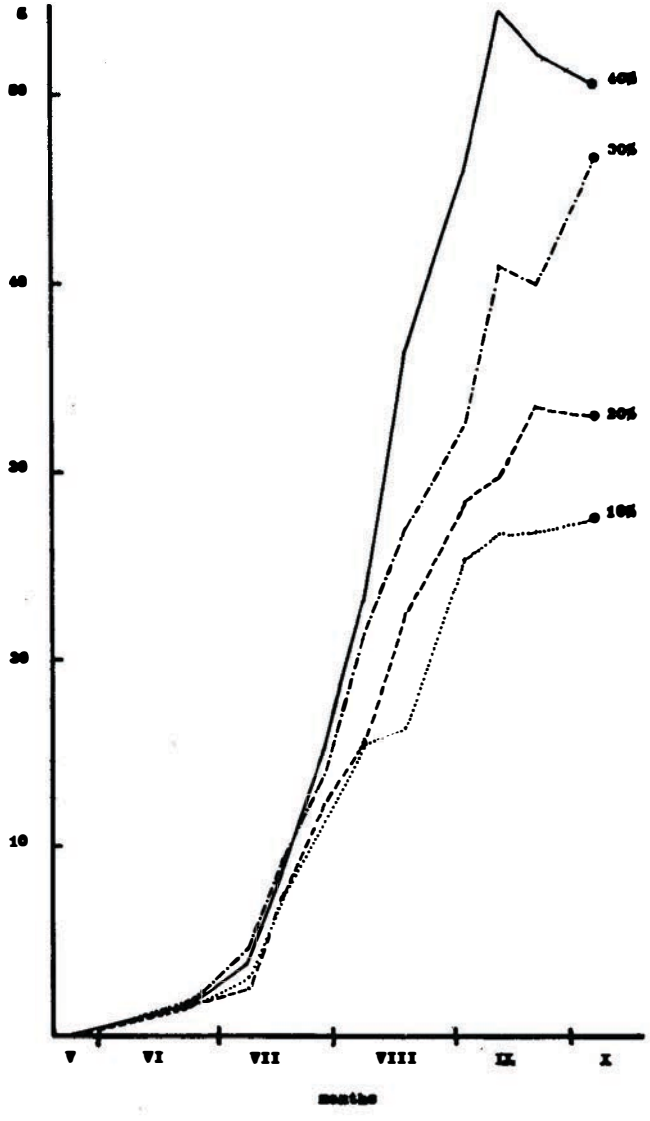

Fig. 2. Growth rate of carp fry as depending upon feeding with pellets of 10, 20, 30 and 40% protein content

Table 5

Final effects of catch taken from experimental ponds of the same 90 000 pcs per ha/13 500 pcs per pound

Protein in the feed (%)	Pond No	Nutrition factor	Catches per ha (kg)	Catches per ha (units)	Aver. weight of 1 unit (g)	Survival rate (%)
10	1	4.56	853	31592	27	35.1
	7	2.89	2007	60808	33	67.6
	9	4.87	1113	44533	25	49.5
$\bar{x}$		4.11	1324.3	45644	28.33	50.73
20	4	3.72	1540	59231	26	65.8
	8	4.38	1293	33162	39	36.8
	12*	3.21	553	7004	79	7.8
$\bar{x}$		4.05	1416.5	46196.5	32.5	51.3
30	5*	2.83	2047	97460	21	108.2
	6	3.00	1973	59798	33	66.4
	11	2.97	1807	46325	39	51.5
$\bar{x}$		2.98	1890	53061	36	58.95
40	2	3.49	1700	33333	51	37.0
	3	2.81	2107	55439	38	61.6
	10	3.60	1407	23060	61	25.6
x		3.30	1738	37277	50	41.40

* ponds not taken into account in statistic calculations (non accurate values due to fortuitous reasons)

There were significant differences in rate of growth between feeding groups from minimum values 23.2 g (fed on pellets of 20% protein content) to maximum values 33.6 g (fed on pellets of 40% protein content) (F-tests, Fig. 2 and Table 6).

The condition coefficient (Fulton factor) value obtained lay within the limits 3.4–3.5. No correlation between this factor and feed protein content was observed.

Dorsal index, for all the experimental groups, was found to be equal to 2.5. No significant correlation (F-test) was found between this index and the type of feed used.

Circumference index was ca 1 and no significant correlation was found between this index and the type of feed used.

Table 6

Values of variables and the "F" test for carp fry with similar survival rate (61.6–67.6%) according to feeds of varying protein content
"+" – significant, "++" – highly significant
$p < 0.05$

Content of protein in the feed	10%	20%	30%	40%	F	Significance
Pond No	7	4	6	3		
Body weight in g	31.0 ±6.25	23.2±4.73	29.6± 5.95	33.6± 9.97	5.0580	++
Weight of the trunk in g	17.8 ±3.55	12.6 ± 3.01	15.5± 2.87	16.6± 5.32	3.4450	+
Weight of the head in g	9.2 ±1.86	5.4± 1.01	8.0± 1.59	8.2± 2.61	7.2717	++
Weight of entrails in g	4.3 ±0.96	3.4± 0.62	3.5± 0.68	4.3± 0.17	3.0909	+
Body length in cm	9.5 ±0.69	8.8± 0.72	9.5± 0.66	9.8± 1.15	4.5400	++
Total length in cm	12.5 ±0.86	10.7± 0.83	11.6± 0.69	11.9± 1.28	5.9730	++
Length of the head in cm	3.3 ±0.27	2.9± 0.25	3.2± 0.23	3.1± 0.35	3.9124	+
Length of the intestine in cm	21.6 ±2.28	19.2± 2.17	18.7± 1.57	19.7± 2.75	3.2153	+
Breadth of the body in cm	1.8 ±0.15	1.6± 0.11	1.7± 0.13	1.7± 0.18	3.9993	+
The highest body depth in cm	3.8 ±0.28	3.3± 0.28	3.6± 0.22	3.7± 0.41	3.8948	+

The dependence of 11 morphometric features on the use of pellets with differing protein content was found to be significant or highly significant; except body circumference. Particular attention was paid to pond No. 7. The fry here, receiving pellets of 10% protein content, showed the highest values (Table 6).

DISCUSSION

The size of stock used in the experiment (90 000 fish/ha) was in accordance with the numbers recommended by Steffens (1969); 100 000–300 000 fish/ha, and by Schäperclaus (1961): 50 000–200 000 fish/ha.

As rate of growth concern, the results indicate, that both weight and length of experimental fish lie within the standard values given by Steffens (1969): 6–15 cm and a weight up to 50 g (average 20–30 g) and are very close to those stated by Schäperclaus (1961), who recorded the ratio of length to weight as follows: 10–12 cm: 20–30 g; 12–14 cm: 40–50 g.

In the present experiment bellet feeding was commenced at a fry weight of 1.1–2.0 g, although Lieder (1965) stated, that the best results were achieved by commencing pellet feeding when the fish were not less than 2.5 g in weight. The present results showed that carp exhibited optimum growth when the feed contained about 40% protein. This stagnating body growth in weight at the end of the experimental period was probably caused by the decrease in water temperature.

The considerable difference in the fish survival rates in individual ponds (Table 5) was caused by the decrease in water temperature together with differences in fertilization of ponds in 1983 as well as fortuitous events (penetration of perch in the case of pond No. 12, bursting of the dam in the case of pond NO. 5).

Obtained values of Fulton factor, according to Czubak (1966), indicates a mediocre degree of nutrition.

Dorsal index was regarded as an indicator of the strain and of the degree of nutrition of fish within a given population (Czubak 1966). This is a variable index, highly dependent on environmental factors (Schäperclaus, 1961; Matlak, 1966). The lower the values of the index, the higher rate of spine's growth and vive versa. This index, for all the experimental groups, suggests poorer development of this feature compared with the results obtained by Matlak (1966) for age – 1 (2.3–2.4).

The decisive factor for the circumference index is nutrition. According to Kiselev (1956), its value, equal to 1.10, indicates the lower limit for poorly fed fish. The lower is the value of this index the better is the rate of growth and vice versa. In Czubak's investigations (1966), this index varied from 1.01 to 1.12 in non-fed carp. He also found the lowest value of the index in carp fed with potatoes (0.98 and 1.02) and the highest fed with cereals (0.94 and 0.96). He calculated in index for 2– and 3-year old carp and his results cannot be compared with age – 1 population observed in present study. However, the author's results are in agreement with the norm calculated by Kiselev (1956) for fry of similar weight and lenght (age – 1).

As morphometric features concern, in connection to used feed, no other previous similar investigation has been found to compare with. The high values achieved by fry from the pond No. 7, owing to the large amounts of natural food, most pro-

bably occurring as a result of mineral and organic fertilization in 1983 (Table 1 and 6). The insignificance of the investigated feed in relation to the fish body circumference (Table 6) suggest that this feature is independent of the feed protein content.

The highest values of the fat of the fry from the pond No. 7 was probably due to the unusual fertility of this pond. Hepher et al. (1965) found a similarly increased protein content and a decrease in the percentage of fat contained in the flesh of fry fed on pellets with a high protein content, compared with those fed on barley.

In conclusion although the nutrition factor proved to be the lowest for feed of 30% protein content (2.98), and the values of the averages for all features were almost the highest, taking into account external factors, the fact that this feed appears to show the highest rate of efficiency should be the subject of further investigation.

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STRESZCZENIE

Badano wpływ paszy o zawartości białka 10, 20, 30 i 40% na wybrane parametry morfometryczne i biochemiczne karpia. Wykazano wysoce istotną zależność odnośnie masy ciała, długości ciała i długości całkowitej. Istotną zależność stwierdzono w przypadku masy korpusu, masy wnętrzności, długości głowy, długości jelita, grubości ciała i najwyższej wysokości ciała. Brak istotnej zależności stwierdzono odnośnie współczynnika od-

żywienia (Fultona), indeksu wygrzbiecenia, indeksu obwodu (wg Kisielewa), obwodu ciała oraz procentowej zawartości białka i tłuszczu w mięsie ryb.

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