Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznań, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wrocław.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

1998
Volume 1
Issue 1
Series FISHERIES

SADOWSKI J., FILIPIAK J. , TRZEBIATOWSKI R. 1998. EFFECTS OF DIFFERENT DURATION OF FEEDING ON RESULTS OF CARP (*Cyprinus carpio*) FRY CAGE CULTURE IN COOLING WATER. **Electronic Journal of Polish Agricultural Universities**, Fisheries, Volume 1, Issue 1.
Available Online http://www.ejpau.media.pl

EFFECTS OF DIFFERENT DURATION OF FEEDING ON RESULTS OF CARP (*Cyprinus carpio*) FRY CAGE CULTURE IN COOLING WATER

Jacek Sadowski, Jarosław Filipiak, Rajmund Trzebiatowski
Department of Aquaculture, Agricultural University of Szczecin, Poland

ABSTRACT

The “Safir” trout feed (Aller Aqua) was offered to carp (*Cyprinus carpio*) fry of 21 + 5 g/ind. initial weight, stocked at a density of 300 ind./m^3 in cages placed in cooling water. Identical rations (5 – 4.0% metabolic weight) were offered for 6, 12, and 18 h per day. The data obtained showed the best results (as indicated by SGR and FCR) of culturing carp of up to about 75 g individual weight were obtained when the feeding took 18 h, 12 – 18 h being the best duration of feeding for the carp weighing 75 – 130 g. No effect of duration of feeding was observed in the carp weighing more than 130 g.

PRINT

Key words: carp, cooling water, feeding time, metabolic daily ration.

INTRODUCTION

Water temperature [1, 10] and oxygen content [15] are regarded as the most important environmental factors affecting fish growth. Neither in open nor in cooling waters can those factors be adjusted by man. For this reason, when culturing fish, attempts are made to optimise fish growth rate by, i.a., using appropriate diets [7, 10, 12] and adjusting feed rations [7, 8, 13]. Relatively few studies were carried out on frequency and duration of feeding [2, 5, 9] as factors determining fish growth rate. For this reason, an attempt was made in this work to study effects of feeding time on results of carp fry culture in cooling water.

MATERIALS AND METHODS

The study was carried out within 1 August – 6 September 1995 at the Agricultural University of Szczecin Department of Aquaculture's Fisheries Research Station (FRS), situated in the vicinity of the "Dolna Odra" power station at Nowe Czarnowo. Carp fry (0+) of about 20 ±5 g mean individual weight, purchased from a pond fish farm, was stocked in 1 m^3 working capacity net cages; the stocking density was 300 ind./m^3.

The fish were fed daily for 6, 12, and 18 h with the 2 – 5 mm pellet diameter "Safir" extruded trout feed (Aller Aqua) containing 47.2% protein, 17.5% fat, and 5308 kcal gross energy content. Daily feed rations, calculated with respect to the fish metabolic weight ($W^{0.8}$), were identical in each experimental treatment and ranged, depending on water temperature and fish weight, within 5.0 – 4.0% (Table 1).

Table 1. Mean individual weight, Specific Growth Rate (SGR) and Food Conversion Ratio (FCR) of 0+old carp fed during 6, 12 and 18 h/day

Feeding time h/day	Date of fish weighing					
	1 Aug	9 Aug	16 Aug	23 Aug	30 Aug	6 Sep
	Mean individual weight (g)					
6	22	37	59	96	142	182
12	21	43	72	120	176	224
18	21	44	78	131	194	244
	SGR					
6		6.65^{c}	6.86^{c}	6.91^{b}	5.58^{a}	4.09^{a}
12		8.61^{b}	7.55^{b}	7.20^{ab}	5.50^{a}	3.97^{ab}
18		9.53^{a}	7.97^{a}	7.47^{a}	5.58^{a}	3.84^{b}
SE		0.10	0.07	0.09	0.11	0.03
	FCR					
6		1.23^{c}	1.10^{c}	0.99^{b}	1.17^{a}	1.27^{a}

12		0.87^{b}	0.95^{b}	0.90^{a}	1.14^{a}	1.26^{a}
18		0.76^{a}	0.87^{a}	0.85^{a}	1.10^{a}	1.29^{a}
SE		0.02	0.02	0.02	0.03	0.02
Stock density (ind./cage)	300	300	300	300	300	300
Food ration ($\%W^{0.8}$/day)	5	5	5	5	5	4

Identical letters accompanying figures in columns denote non-significant difference at alfa=0.05. SE, standard error pooled.

The magnitude of daily food ration, dispensed each day from 9:00 hours on by timer-fitted feeders, was calculated from the formula:

$$DFR = \frac{MFR \cdot n \cdot W^{0.8}}{100} \quad (1)$$

where:

DFR, daily food ration (kg),
MFR, metabolic food ration (%),
n, number of fish in a cage,
W, mean individual fish weight (kg).

To follow the dynamics of changes in the major culture parameters, and to adjust the food rations, the fish from all the cages were weighed, to 0.05 kg, every 6 – 8 days. The data obtained served to calculate mean values of Food Conversion Ratio (FCR), Specific Growth Rate (SGR), apparent Net Protein Utilization (aNPU), Energy Retained (ER), and apparent Lipids Retained (aLR) as in the formulae below:

$$SGR = \frac{\ln W_{ik} - \ln W_{ip}}{T} \cdot 100\% \quad (2)$$

where:

T, number of days elapsed,
W_{ip}, initial mean individual fish weight (g),
W_{ik}, final mean individual fish weight (g);

$$FCR = \frac{P}{W_k - W_p} \quad (3)$$

where:

P, amount of food offered (kg),
W_k, final weight of fish in a cage (kg),
W_p, initial weight of fish in a cage (kg);

$$aNPU = \frac{B - B_0}{N_p} \cdot 100\% \quad (4)$$

where:

B, crude protein weight in fish body on termination of the experiment (g),
B_0, crude protein weight in fish body before the experiment (g),
N_p, crude protein weight in the food offered (g);

$$ER = \frac{E_k - E_p}{EP} \cdot 100\% \quad (5)$$

where:

E_k, gross energy content in fish body on termination of the experiment (kcal),
E_p, gross energy content in fish body before the experiment (kcal),
EP, gross energy content in the food offered during the experiment (kcal);

$$aLR = \frac{T - T_0}{T_p} \cdot 100\% \quad (6)$$

where:

T, weight of lipids contained in fish body on termination of the experiment (kg),
T_0, weight of lipids contained in fish body on day 1 of the experiment (kg),
T_p, weight of lipids contained in the food dispensed during the experiment (kg).

To check for significance of differences between the experimental treatments, the LSD test at $P = 0.05$ was applied to all the parameters calculated.

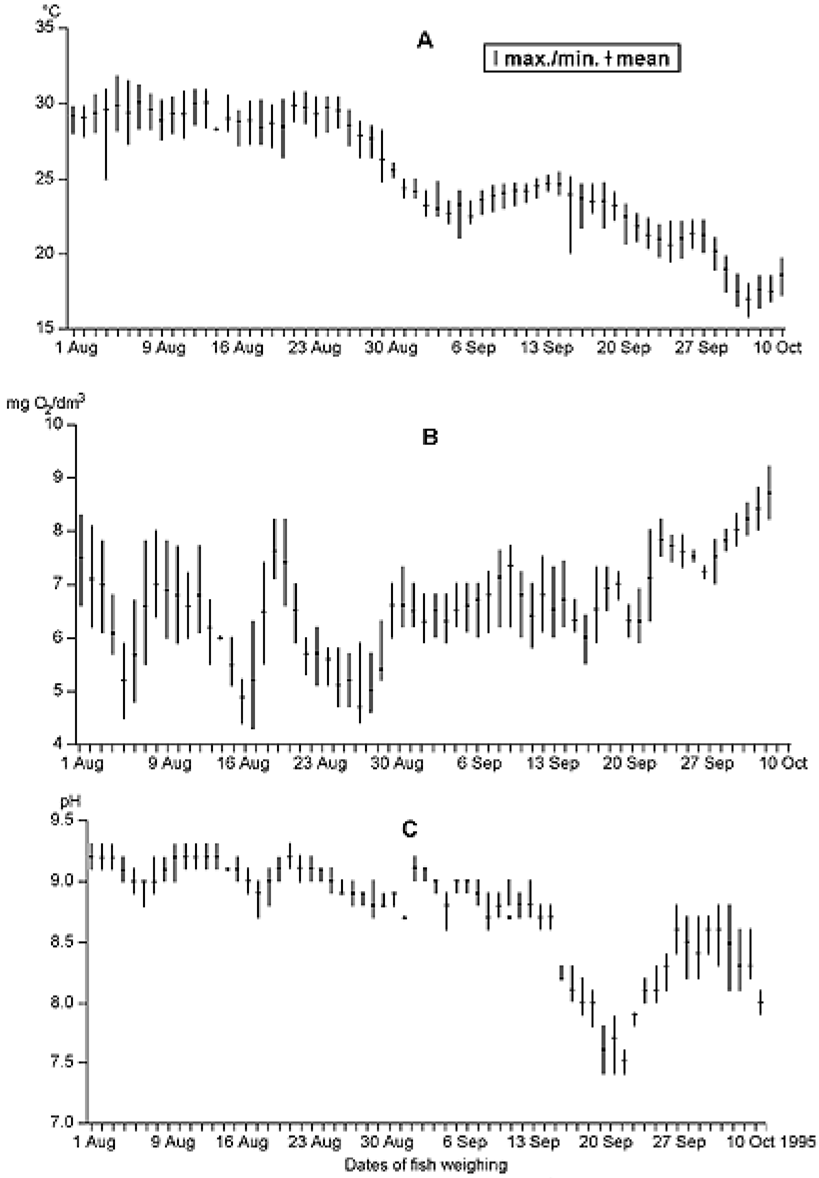
At the beginning and on termination of the experiment, 5 individuals were picked from each experiment treatment to determine, after homogenisation, per cent contents of dry matter (drying for 12 h at 105°C), crude protein (Kjeldahl technique, Kjeltec 1026 apparatus), lipids (Soxhlet technique; 12 h ethyl ether extraction), and ash (combustion for 12 h at 550°C).

PRINT

Similar assays were performed on the feed, the carbohydrate content being calculated in both cases as a difference between the dry matter and the sum of the remaining components. To calculate the gross energy content, the values given by Brody [4] as 5.65 kcal/g crude protein; 9.45 kcal/g lipids; and 4.1 kcal/g carbohydrates were used.

Water temperature, oxygen content, and pH were determined quasi-continuously (every 60 min) with an automatic recorder. The mean, maximum, and minimum daily values of the environmental parameters are shown in Figs 1A-C.

Fig. 1. Diurnal changes of cooling water temperature (A), oxygen content (B), and pH (C) during the experiment



RESULTS AND DISCUSSION

Frequency with which the feed is administered is one of major elements of fish feeding regime. In the present study, timer-equipped feeders dispensed the feed continuously, in small portions, for different periods of time.

Effects of feeding time on results of culture are related to the fish gut capacity and duration of food passage through the gut, the passage time decreasing with increasing water temperature [18]. In the case of rainbow trout, the frequency of feeding higher than twice a day did not result in an increase in the amount of food consumed [3]. According to Ruohonen [16], the rainbow trout growth rate increases with frequency of feeding, the highest growth rate occurring at 60 feed portions a day. Similar experiments demonstrated an optimal feeding frequency to be two portions per day for *Ictalurus punctatus* [2], one portion per day for *Channa striatus* [17] and *Salvelinus alpinus* [11], and one portion every other day for *Epinephelus tauvina* [6].

In their studies on feeding carp individuals weighing 173 mg, Charles et al. [5] found the highest growth rate to accompany 3 food portions dispensed per day. On the other hand, Omar and Gunther [14] showed that a higher SGR was attained in feeding carp 6 portions a day than at 4 daily portions. The experiments referred to above did not involve feeding frequencies higher than 6 feedings a day, i.e., the frequencies much lower than those applied in our study. It was in the experiment described by Hogendoorn [9] only that the frequency of feeding the African catfish (*Clarias gariepinus*) of 0.5 g/ind. was similar to that in this work. We demonstrate that, when the timer-equipped feeders dispense the feed over 24 h, a higher growth rate is attained than when the feeders work for 12 h (during the day or at night) or when the food is offered two or four times a day. At the same time, no statistically significant differences between feed conversion ratios obtained with 4 portions a day and with 24 h feeding could be demonstrated. The highest growth rate of individuals weighing about 75 g each was arrived when the food was offered for 18 h (Table 1). The best results with respect to the fish weighing from 75 to about 120 – 130 g each were recorded at 12 and 18 h feeding times (no significant differences in SGR and FCR between the two treatments) (Table 1). Once the fish grew to more than 130 g/ind., neither their growth rate nor feed conversion ratios showed statistically significant between-treatments differences. On termination of the experiment (6 September), the fish were still kept in the cages and fed identical feed rations. The initial differences in growth rates resulted in mean individual weights as recorded on 4 October, i.e., 63 days after stocking, being 385, 492, and 516 g for the fish fed for 6, 12, and 18 h a day, respectively. Thus the differences emerging during the experiment resulted in the final weight of fish fed for 18 h a day to be by as much as 34% higher than that of the fish fed for 6 h daily.

Among the data reported in Table 2, noteworthy is the aLR value, the lowest in those fish fed for 18 h a day and resulting in the lowest body lipid content (Table 3). This result is most likely related to the duration of feeding. The fish obtaining their entire daily food ration (and thus the entire daily energy supply) during 6 h adjusted their metabolism accordingly: they digested more feed and accumulated more energy per unit time than those fish obtaining an identical food supply during a longer period of time, which most probably resulted in a higher accumulation of energy (in the form of body lipids) in the first. Moreover, those fish feeding for 12 and 18 h were forced to prolong their feeding activity, which may have resulted in their lower lipid retention.

PRINT

Table 2. Final values of mean body weight, Specific Growth Rate (SGR), Food Conversion Ratio (FCR), apparent Net Protein Utilization (aNPU), apparent Lipid Retained (LR) and Energy Retained (ER) of 0+ old carp fed during 6, 12 and 18 h/day

Time of feeding (h/day)	Fish individual weight (g)		SGR (%/day)	FCR	aNPU (%)	aLR (%)	ER (%)
	initial	final					
6	22	182	6.09^{c}	1.21^{b}	24.2^{b}	90.4^{b}	40.3^{a}
12	21	224	6.70^{b}	1.06^{a}	26.2^{a}	89.6^{b}	41.1^{a}
18	21	244	7.04^{a}	1.01^{a}	26.1^{a}	83.5^{a}	39.1^{a}
SE			0.04	0.02	0.23	0.77	0.36

For explanations see [Table 1](#).

Table 3. Body chemical composition (%) of 0+ carp at the start and in the end of experiment

Feeding time (h/day)	Dry matter	Crude protein	Lipids	Ash
	Start of experiment			
	25.8	12.5	14.1	1.3
	End of experiment			
6	33.5	13.7^{a}	18.8^{c}	1.3
12	32.5	13.6^{a}	17.2^{b}	1.2
18	30.9	13.6^{a}	16.1^{a}	1.2
SE		0.10	0.16	

For explanations see [Table 1](#).

To sum up, duration of feeding is one of the most important elements of carp fry culture in cages placed in cooling water. An appropriate adjustment of feeding time allows to considerably improve the results of culture. Prolonged duration of feeding seems to improve effects of culturing fish of a low individual weight as the carp have been observed to be capable of feeding throughout the day. Thus it seems purposeful to carry on studies on effects of feeding duration in order to further improve carp culture and feeding regimes.

CONCLUSIONS

1. Effects of duration of feeding on growth rate and feed conversion ratios in carp depend on the fish individual weight.
2. The best culture results are obtained when carp weighing 75, 75-130 g/ind., and more are fed for 18, 12, and 6 h a day, respectively.
3. Extension of feeding time results in reduced aLR and body lipid content of carp.

REFERENCES

1. Adelman I. R.: Influence of temperature on growth promotion and body composition of carp (*Cyprinus carpio*) due to bovine growth hormone, Trans. Amer. Fish. Soc. 107 (5), 1978, 747-750.
2. Andrews J.W., Page J.W.: The effects of frequency of feeding on culture of catfish, Trans. Am. Fish. Soc. 104, 1975, 317-321.
3. Beamish F. W. H. Grayton B. D.: Effects of feeding frequency on food intake, growth and body composition of rainbow trout (*Salmo gairdneri*), Aquaculture 11, 1977, 159-172.
4. Brody S.: Bioenergetics and growth, Reinholt, New York 1945.
5. Charles P.M., Sebastian S.M., Ray M. C. V., Marian M. P.: Effect of feeding frequency on growth and feed conversion of *Cyprinus carpio* fry, Aquaculture 40, 1978, 293-300.
6. Chua T., Teng S.: Effects of feeding frequency on the growth of young estuary grouper, *Epinephelus tauvina* (Forskal), cultured in floating net cages, Aquaculture 14, 1978, 31-47.
7. Filipiak J.: Effect of different total protein level feed doses on growth of carp (C_{1-2}) cage reared in heated water. In: Intern. Conf. Aquaculture and the Environment, Dublin June 10-12 1991, Spec. Publ. EAS 14, 1991, 101-102.
8. Filipiak J., Sadowski J., Trzebiatowski R.: Comparative analysis of results of using different food rations in juvenile wels (*Silurus glanis*) culture, Acta Ichth. Piscat. 27 (1), 1997, 41-51.
9. Hoogendoorn H.: Controlled propagation of the African catfish, *Clarias lazera* (C. & V.). 4. Effects of feeding regime in fingerling culture, Aquaculture 24, 1981, 123-131.
10. Jauncey K.: Carp (*Cyprinus carpio* L.) nutrition - a review. In: Recent Advances in Aquaculture, ed. J. F. Muir, R. J. Roberts, Groom Helm LTD. London 1982, 216-263.
11. Jobling M.: Effect of feeding frequency on food intake and growth of Artic charr, *Salvelinus alpinus* L., J. Fish. Biol. 23, 1983, 177-185.
12. Ogino Ch., Saito K.: Protein nutrition in fish. I. The utilisation of dietary protein by young carp, Bull. Jap. Soc. Sci. Fisheries 36 (3), 1970, 250-254.
13. Omar B. A., Günther K. D.: The optimum feeding levels for growing of mirror carp (*Cyprirnus carpio* L.) in intensive culture, J. Anim. Physiol. and Anim. Nutr. 57 (4), 1987a, 180-190.
14. Omar B. A., Günther K. D.: Studies on feeding of mirror carp (*Cyprinus carpio* L.) in intensive aquaculture. 2. Effect of frequency and increased levels of feeding, J. Anim. Physiol. and Anim. Nutr, 57 (4), 1987b, 172-180.
15. Pedersen C. L.: Energy budgets for juvenile rainbow trout at various oxygen concentrations, Aquaculture 62, 1987, 289-298.
16. Ruohonen K.: Biological models related to automatic control in aquaculture. A case study: Automatic feeding control. In: lFAC Automation and Data Processing in Aquaculture, Trondheim Norway, 1986, 75-80.
17. Sampath K.: Preliminary report on the effects of feeding frequency in *Channa striatus*, Aquaculture, 40, 1984, 301-306.
18. Steffens W.: Grundlagen der Fischernährung. VEB Gustav Fischer Verlag Jena 1985.

Submited: April 1998

Jacek Sadowski, Jarosław Filipiak, Rajmund Trzebiatowski
Department of Aquaculture,
Agricultural University of Szczecin
4 Kazimierza Królewicza St.,71-550 Szczecin, Poland
