Arch. Ryb. Pol.	Archives of Polish Fisheries	Vol. 7	Fasc. 2	321 - 328	1999

EFFECT OF BETAFIN ADDITION ON SELECTED INDICES OF CARP FRY REARING IN PONDS

Antoni Przybył, Jan Mazurkiewicz, Maria Madziar, Marek Hallas

The August Cieszkowski Agricultural University in Poznań

ABSTARCT. Three feed mixtures obtained with the extrusion method, and balanced on the isonitric and isocaloric levels, were tested. BETAFIN preparation containing 96% of betaine was added to the experimental feeds B and C, in the amount of 0.15 and 0.2% respectively.
The material consisted of carp fry of average individual weight 6.25 g. The feeding test was carried out for 42 days in the experimental ponds of 40 m^2 in area.
Based on the feeding test results, it was found that carp fry utilized in the most effective way the C feed, containing 0.2% of the investigated preparation. The best food conversion ratio of 1.22 and the highest survival rate were obtained in this group.

Key words: CARP, BETAFIN (BETAINE), FEED MIXES, EXTRUSION, FEEDING

INTRODUCTION

In order to increase the effectiveness and profitability of fish production, attempts have been made to introduce different feed additives into fish diets, such as: growth stimulators, enzymes, amino acids, herbal preparations aiming primarily at an improvement of the animal health, increase of body weight increments and decrease of food consumption.

The substances which affect positively body increments, and which decrease food consumption include betaine. This substance participates in the metabolic processes. Betaine (trimethylglycine) is known as one of the main organic products developing during choline oxidation in the animal body (choline - aldehyde-betaines – betaine). It has been proven that betaine plays an important role in the development of methionine, being particularly important in case of its deficiency in the food (Clarke et al. 1994).

BETAFIN was used in this study. It was produced by Cultor Ltd. Finnsugar Bioproducts, and contained 96% of natural plant originated betaine compound (trimethylglycine).

The objective of our studies was to determine the effect of BETAFIN addition to carp fry feed mixtures on selected rearing indices: growth rate, food conversion ratio, and survival rate in pond conditions.

MATERIAL AND METHODS

The experiment was carried out in the Experimental Station of Feed Production Technology and Aquaculture in Muchocin. The tests were carried out in nine experimental ponds of 40 m^2 and 1.5 m deep. Pond bottom and slopes were covered with a 10 cm layer of gravel. Minimal water flow was maintained in order to provide the optimal physicochemical parameters.

Feeding test lasted for 42 days, from 30.06 to 10.08.98. The experiment was carried out in three experimental groups, and three replications, with one variable experimental factor: the type of the applied feed. 300 fish were used in each experimental variant. The experimental material consisted of selected carp fry having similar individual weight of 6.25 g/pc.

Composition of the experimental feeds was calculated using a computer program, in form of a linear software written by Simplex method in Turbo Pascal 5.0.

Composition of the fry feeds is shown in table 1.

TABLE 1

Composition of feed mixtures (%)

Feed components	Feed mixtures		
	A	B	C
Fish meal	12.0	12.0	12.0
Blood meal	8.0	8.0	8,0
Meat and bone meal	15.0	15.0	15.0
Soya meal	11.0	11.0	11.0
Rape meal	6.0	6.0	6.0
Lupin seeds c.v. Sur	9.0	9.0	9.0
Maize	30.7	30.5	30.6
Soya oil	6.5	6.5	6.5
Soya lecithin	0.5	0.5	0.5
Polfamix W	1.2	1.2	1.2
Vitazol AD_3EC	0.1	0.1	0.1
Betafin	-	0.15	0.2
TOTAL	100.0	100.0	100.0

Basic diet was supplemented with a vitamin and mineral mixture Polfamix W (1.2%), and a vitamin mixture AD_3EC (0.1%). The feed mixture B was supplemented with 0.15%, and the mixture C with 0.2% of BETAFIN.

In order to improve digestibility and assimilability of the feed mixtures, the diets were enriched with soya lecithin as the source of phospholipides. Its emulsifying propreties also seemed to be important.

The experimental feeds were subject to a conditioning process. Then they were agglomerated by the barothermal method in an endogenous single-start worm extruder (type N-60, Metalchem, Gliwice) with a matrix of 6 mm openings. The most favourable extruded feeds were obtained with the following technological parameters:

- cylinder temperature in the growing pressure zone 97^{o}C
- cylinder temperature in the high pressure zone 109^{o}C
- head temperature 122^{o}C
- speed of worm rotations 52 rev./min.

The extrudate was cut with a rotational knife into 10 mm long pieces, spread on sieves, cooled down and dried in a heated air stream. Width of the pellets was 6.6 mm after drying. The pellets were disintegrated in a cylinder crumbler RUT-10, and segregated into the following fractions: I – 1.25 to 1.6 mm; II – 1.6 to 2.4 mm; III – 2.4 to 3.15 mm. They were oiled with heated soya oil in the amount of 3% sprayed in a pelletizing drum.

The tested feeds were given manually, over the feeding tables. The daily rations were determined according to the norms given by SCHRECKENBACH (1987), depending on water temperature and the actual weight of fish.

Daily feed ration was distributed in five portions at the following hours: 9:00, 11:00, 13:00, 15:00, 17:00.

The following physico-chemical parameters were checked every day:

- water temperature (^{o}C), up to 0.1 ^{o}C;
- water content of dissolved oxygen in mg O_2/dm^3 by Winkler's method with the use of Hanna Instruments.

The following elements were identified in the experimental feeds: total protein by Kjeldahl's method using the analyser of the Danish firm Foss Electric; crude fibre by the Figerton System of Tecator Co. Dry weight, crude ash, and crude fat were determined by Skulmowski's methods (1974).

The mineral components: phosphorus (P) and calcium (Ca) were identified by the flame photometer Flapho 4 of Carl Zeiss, Jena (Gawęcki 1994). Amino acids were determined after sample hydrolysis in 6n HCl at 105 ^{o}C for 23 hours, using the AAA 339 analyser (Microtechnic); tryptophane was determined by the calorimetric method according to Votisky and Gunkel (1989).

The organic amino acid index – Chemical score (Cs) was calculated, and essential amino acid index (EAAI) was established.

The digistible energy of the model diets was calculated from the chemical composition using the conversion factors of digistible energy for fish: extruded carbohydrates – 2.5 Kcal; protein – 5.2 kcal, and fat – 8.5 Kcal (Halver 1988).

Water stability of the experimental feeds was evaluated by the Hastings-Hepher method (Hepher 1968).

Specific growth rate (SGR) and survival rate were used as the measures of the feeding results. Food conversion ratio (FCR), and protein efficiency ratio (PER) were calculated as well.

The results of studies and the biotechnical results of the feeding test, as well as food conversion ratios were calculated using our own computer program (S-4) (Copyright of the Agricultural University, Poznań). The final average weights of fish were subject to unifactorial analysis of variance (Martin 1972).

RESULTS AND DISCUSION

During the feeding experiment, the mean 24-hour values of water temperature oscillated between 17.4 and 25.0^{o}C, and the mean content of oxygen dissolved in water was between 2.4 to 9.3 mg O_2/dm^3.

Losses of the extruded feeds were 33.1% in the Hastings and Hepher tests, and oxygen consumption expressed in mg O_2/dm^3 reached the value of 60.7.

The examined experimental feeds were made of the same raw materials and according to the same recipe. The following chemical composition was determined in the feeds: total protein-36.5%, crude fat-11.8%, crude fibre-4.1%, NFE (Nitrogen Free Extractives)-32.8%, crude ash-6.9%, total phosphorus-1.19% and calcium-2.01%.

The feeds were prepred on a balanced isonitric and isocaloric level. The calculated digestible energy of the experimental diet was high: 3721 Kcal, at energy to protein (E/P) ratio = 10.1 Kcal per one gramme of protein (table 2).

Table 3 presents the amino acid composition, organic amino acid index (CS), and the essential amino acid index (EAAI). The following content of exogenic amino acids was found in the experimental feeds (g in 100g of protein): arginine-5.904, histidine-3.288, lysine-6.193, tryptophane-3.771, phenyloalanine and tyrosine-7.150, methionine-2.372, treonine-3.463, leucine-7.785, valine-5.100.

The limiting amino acids (CS) were: I-(methionine with cystine)-40.86; II-(isoleucine)-47.68; and III-(valine)-68.92.

TABLE 2

Chemical composition of the experimental feeds (%), energy level, E/P ratio

Components	Feed mixtures
Total protein	36.5
Raw fat	11.8
Nitrogen Free Extractives	32.8
Crude fibre	4.1
Crude ash	6.9
Total phosphorus	1.19
Calcium	2.01
Digestible energy in Kcal/kg	3721
E/P ratio	10.1

TABLE 3

Content of exogenous amino acids in the studied feeds in g/100g of protein,
Chemical Score (CS) and EAAI

Amino acid	Feed mixtures
Arginine	5.904
Histidine	3.288
Lysine	6.193
Tryptophane	3.771
Phenyloalanine + Tyrosine	7.150
Methionine + Cystine	2.372
Threonine	3.643
Leucine	7.785
Isoleucine	3.293
Valine	5.100
CS*	I Methionine + Cystine – 40.96 II Isoleucine – 47.68 III Valine – 68.92
EAAI**	74.22

**CS-Chemical Score*
***EAAI-Essential Amino Acid Index*

The results of the experiment are shown in table 4.

The highest final mean individual weight was attained by carps in the experimental group A – 50.54 g, while the lowest value was observed in group B – 47.40 g. Differentiated growth rate of the fish was also confirmed by the 24-hour increments of the mean individual weight (SGR): 2.16% in group A and 2.02% in group B. The

TABLE 4

Results of carp fry feeding

Specification	A	B	C
Initial number of fish (pcs)	300	300	300
Mean individual weight (g)	6.25	6.24	6.27
Total weight of the fish (g)	1875.0	1872.0	1881.0
Final results			
Final number of fish	236	268	273
Total weight of the fish (g)	11926.6	11824.5	13135.5
Mean individual weight (g)	50.54	44.12	48.12
Increment of total weight (g)	10051.6	9952.5	11254.5
SGR Specific Growth Rate (%)	2.16	2.02	2.11
FCR Food Conversion Ratio	1.37	1.38	1.22
PER Protein Efficiency Ratio	2.0	1.98	2.24
Survival (%)	78.7	89.3	91.6
Total production kg/ha	993.9	985.4	1094.6

lowest survival rate was recorded in group A – 78.7%, and the highest in group C – 91.0%.

Nutritive value of the investigated feeds for carp fry is also characterized by food conversion indices. The mean values of food conversion ratio (FCR) oscillated between 1.22 (group C) and 1.38 (group B), and the protein efficiency ratio (PER) was 2.24 and 1.98 respectively.

The tested feeds were characterized by an insufficient water stability. According to the criteria of Szumiec and Stanny (1975), based on weight loss of the pellets, they received a „sufficient" mark, while oxygen consumption index resulted in „good" mark.

Content of total protein in the feeds could be regarded as correct (Ogino 1980). Total phosphorus level was too high (1.19%), exceeding the recommended content of 8 g/kg (Wiessman et al. 1988). This should be regarded as a draw-back from the point of view of environment protection.

No works have been found in the available literature on the use of betaine in carp feeding. Studies on this problem concentrated mainly on salmonid species and some sea fish. Betaine, next to glicyne (Machic, Mitchel 1985), belongs to a narrow group of chemical compounds (nutritional taste stimutators) increasing the feeding behaviour in cultured fish. The effect of betaine addition on the growth of coho salmon (Oncorhynchus kisutch Walb.) was investigated by Castro et al. (1998). Adding the Finn Stinn preparation containing betaine to the diet, the authors improved survival rate in the reared fish by 2.17%, the FCR changed from 1.51 to 1.27, and SGR increased from 1.66 to 1.75%. Positive effect of Finn Stinn preparation on the specific growth rate (SGR), of 1%, was also found by Clarke et al. (1994) in chinook salmon (*Ocorhynchus tschawytscha*).

The effect of betaine addition to the diet for rainbow trout was investigated by Rumsey (1991), Can and Sener (1992) and Virtanen et al. (1994). Their results are not explicit. In the experiment of Rumsey (1991), addition of betaine did not contribute to the increment of fish body weight. On the other hand, Virtanen et al. (1994), who added Finn Stinn preparation (1%) to the diet, found a 12% increment of body weight in the rainbow trout, and mortality rate decreased by 60%.

Values of PER and FCR obtained in the experiment enable conclusion that carps utilized most effectively the C diet, containing 0.2% of BETAFIN, while diet B, containing 0.15% of that preparation, was utilized in a less effective way.

Final results of studies characterizing the SGR and the body weight increments indicate that suitability of the experimental feeds B and C with the addition of BETAFIN preparation to rear carp was differentiated. This was confirmed by ststistical analysis at the level of $\alpha<0.05$.

REFERENCES

Can K., Sener E. (1992): Effect of betaine-added starter feeds on the growth of rainbow trout (*Oncorhynchus mykiss*) fry. Su-Urum. Degr. J. Aquat. Prod. 6, 1: 95-104.

Castro H., Battaglia I., Virtanen E. (1998): Effects of Finn Stinn on growth and sea water adaptation of Coho salmon. Aquaculture 168, 1-4: 423-429.

Clarke W.C., Virtanen E., Blackburn I., Higgs D.A. (1994): Effect of dietary betaine/amino acid additive on growth and sea water adaptation in yearling chinook salmon. Aquaculture 121, 1-2: 137-145.

Gawęcki K. (1988): Ćwiczenia z żywienia zwierząt i paszoznawstwa - Wyd. AR w Poznaniu, Poznań.

Halver E.J. (1988): Fish Nutrition Akademic. Press, San Diego.

Hepher A. (1968): A modification of Hastings method for the determination of water stability of Fish feed pellets. Symposium „New developments in carp nutrition„ Fifth session European Inland Fisheries Advisory Commission ,Rome 49-54.

Machic A.M., Mitchell A.I. (1985): Identification of gustatory feeding stimulants for fish application in aquaculture. Int. Symp. On Feeding in Fish. Aberdeen. 10 Juli 1984: 177-189.

Martin J. (1972) - Podstawy matematyki i statystyki dla biologów, lekarzy i farmaceutów. PZWL W-wa.

Ogino C. (1980): Protein requirement of carp and rainbow trout – Bull. Jap. Soc Sci. Fish. 46: 385-388.

Rumsey G.L. (1991): Choline-betaine requirements of rainbow trout (*Oncorhynchus mykiss*). Aquaculture 91, 1-2: 107-116.

Schreckenbach R., Steffens W., Zobel H. (1987): Technologien, Normen und Richtwerte zur Fischproduktion. Berlin: 23-27.

Skulmowski J. (1974): Metody określania składu pasz i ich jakości - PWRiL Warszawa.
Szumiec J., Stanny L. (1975): Ocena stabilności pasz granulowanych stosowanych w żywieniau karpia - Gosp. Ryb.12: 3-5.
Wiesman D., Scheid H., Pfeffer E. (1988): Water pollution with phosphorus of dietary origin by intensively fed optimal rainbow trout pellet feeds. Arch. Fish. 27, 1: 1-29.
Virtanen E., Hole R., Resink I.W., Slinning E.K., Junila M. (1994): Betaine amino acid additive enhances the seawater performance of rainbow trout. Aquaculture 124, 1-4: 220.
Votisky E., Gunkel J. (1989): Colorimetric determination of tryptophan in feeds. II. International Symposium on Amino Acids, Brno: 113-119.

STRESZCZENIE

WPŁYW DODATKU BETAFINU NA WYBRANE WSKAŹNIKI CHOWU KARPIA W STAWACH

Celem badań było określenie wpływu dodatku preparatu BETAFIN w mieszankach paszowych dla narybku karpia, na wybrane wskaźniki hodowlane, takie jak: tempo wzrostu, współczynnik pokarmowy, przeżywalność, w podchowie
w warunkach stawowych. Betafin jest preparatem produkowanym przez firmę Cultor Ltd. Finnesugar Bioproducts, który zawiera 96% naturalnego związku, pochodzenia roślinnego betainy (trójmetyloglicyny).

Test żywieniowy przeprowadzono w stawkach doświadczalnych o powierzchni 40 m^2 i obsadzie 100 szt. narybku. W trakcie doświadczenia średnia dobowa temperatura wody wahała się, od 17,4 – 25,0 ^{o}C. Do badań użyto narybku karpia o średniej początkowej masie jednostkowej 6,25 g/szt. Test żywieniowy trwał 42 dni. Badaniami objęto 3 mieszanki paszowe zbilansowane na poziomie izoazotowym (36,5% białka) i izokalorycznym (3721 kcal energii strawnejna 1kg).

Pasze doświadczalne B i C zawierały preparat BETAFIN, na dwóch poziomach: 0,15 i 0,2%. Mieszanki paszowe uformowane zostały metodą obróbki barotermicznej.

Wartość pasz doświadczalnych oceniono metodami chemicznymi i wzrostowymi. Badania wykazały, że narybek karpia najefektywniej wykorzystywał dietę C, zawierającą 0,2% badanego dodatku paszowego. W tej grupie doświadczalnej uzyskano najkorzystniejszy współczynnik pokarmowy – 1,22 i najwyższą przeżywalność obsad – 91%.

Adresy autorów:
Dr hab. Antoni Przybył prof.nadz.
Dr hab. Maria Madziar
Mgr inż. Jan Mazurkiewicz
Mgr inż. Marek Hallas
Katedra Rybactwa Śródlądowego i Akwakultury
Akademia Rolnicza im. Augusta Cieszkowskiego w Poznaniu
60 – 625 Poznań, ul. Wojska Polskiego 71,