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PRELIMINARY RESULTS REGARDING THE EFFECTS OF DIETARY-PROTEIN LEVELS ON THE GROWTH PERFORMANCE AND FEED EFFICIENCY OF COMMON CARP FRY

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Abstract

This experiment aimed to determine the optimum dietary protein level for common carp fry (Cyprinus carpio L.), with the average initial body weight of 2,98 g ±0,05 g (W) and the total length of 5,42±1,17mm (TL). The experiment was conducted for 31 days in a recirculating aquaculture system (RAS). The fish were divided into four experimental groups, in duplicate: V1-30% crude protein and 7% lipids, V2-44% crude protein and 22% lipids, V3-45% crude protein and 16% lipids, and V4- 50% crude protein and 14% lipids.Weight gain (WG) and SGR significantly increased (p<0.05) as dietary protein levels increased.Feed conversion recorded the best values at 50% protein diets, the values being considerably lower than those from V1, V2,and V3 variants. Based on the obtained data, it was estimated that the optimal level of protein for fry carps weighing between 2,9 g and 7 g was 50%.

Keywords:*protein level, growth performance, common carp, recirculating aquaculture systems (RAS).*

INTRODUCTION

Aquaculture is increasingly contributing to world food production, being the fastest food producing sector worldwide, and the cheapest source of animal protein with total global production of 73.8 million metric tons (FAO, 2016).

Common carp (*Cyprinus carpio L.*) is one of the main aquaculture species in many European, Latin American and Asian countries, and is estimated that the global fishery and aquaculture production reached approx. 4,556 million tons in 2016 (FAO, 2018). The fast growth rate (Mohapatra and Patra, 2014) high environmental tolerance, ease of handling, tolerance to high stocking densityand ability to utilize effectively artificial diet (Kirpichnikov, 1999) has made it one of the most culture species from Romanian farms.In our country, carp aremainly raised in earth ponds and represent around 33.36% of the fish population structure (Annual report of National Agency for Fisheries and Aquaculture, 2016).

Taking into consideration the growing demandfor carp consumption, it is necessary to develop new technologies, to increase production processes. One of the methods would be to obtain carp larvae outside the breeding season and to grow them during the winter season in recirculating aquaculture systems (RAS), in optimum conditions, and later provided growing in earth ponds (Kristan et al., 2012). This offers an opportunity to increase carp production significantly and reduce the production cycle length, a fact which has the effect of lowering costs and contribute to the profitability of the fish farms.

Although common carp is one of the most frequently cultured freshwater fish species, many aspects regarding the aquaculture in RAS systems arenot studied enough, and therefore, it is essential to determinate the optimal protein requirements for each stage of development in these culture systems.

Because protein is the most expensive macronutrient in the fish diet, the feeding cost accounts 40-50% of the production cost (Steven, 2011) and a key factor for the successful development of carp aquaculture it may be reducing the cost of food.

In this context, thepresent study aimed to investigate the effects of different dietary protein levelson growth performanceof fry carp.

MATERIALS AND METHODS

Experimental design. The experiment was carried out at the Romanian Center for the

Modeling of Recirculating Aquaculture Systems (MoRAS), the facility of University Dunărea de Jos, Galați, Romania, during 31 days. The recirculating system is composed of eight rearing units (water volume of 600 L each), mechanical filter, biological filter, UV lamp for water sterilization and disinfection, pumps, components for the management of dissolved gases (oxygen and carbon dioxide), independent electrical generator and was previously described in the paper of Andrei (2017).

One thousand six hundred fry carps with almost similar body weight and size (mean weight 2.98±0.05g) were randomly distributed in duplicate groups at the rate of 200 fish per trough for each experimental trial. The fish were hand fed, in three meals per day (09:00, 14:00 h, and 18:00 h) in split-rations at 3.2 % body weight (BW), or 10 g kg^{-1} metabolic weight. Four experimental variants were designed to contain four levels of protein: V1-30% crude protein, V2-44% crude protein, V3-45% crude protein, and V4-50% crude protein. Ingredients and nutrient contents of the experimental diets are presented in Table 1.

Table1. Proximate composition of experimental diets

Ingredients	U.M	Diet 1	Diet 2	Diet 3	Diet 4
Crude protein	%	30	44	45	50
Crude lipids	%	7	22	16	14
Ash	%	8	7.2	7	
Raw cellulose	%	5	1.8	2	2
Lysine		-	-	-	2.5
Phosphorus	%	0.8	1.02	1	1
Copper	mg/kg	30	5	5	6
Calcium	%	1.2	1.7	1.3	-
Sodium	%	0.2	0.3	0.3	-
Vitamin A	IU/kg	10 000	10 002	10 000	20 000
Vitamin D3	IU/kg	1 800	1 463	-	2 000
Vitamin E	mg/kg	60	200	200	200
Vitamin C	mg/kg		250	150	200

The physicochemical parameters of water (temperature, dissolved oxygen,and pH) were recordeddaily, with the sensors from the system and once a week, the nitrogen compounds ($N\text{-}NO_2^-$, $N\text{-}NO_3^-$, $N\text{-}NH_4^+$,) were monitored using Spectroquant Nova400 type spectrophotometer, compatible with Merk kits. The water sample for analysis was collected early in the morning before the feeding was done.

Calculations

Fish were weighed and measured individually at the beginning, and the end ofthe experiment and the following variables were calculated:

- Weight Gain (W) = Final Biomass (Wt) - Initial Biomass (W0) (g)
- Food Conversion Ratio (FCR) = Total feed (F) / Total weight gain (W) (g/g)
- Specific Growth Rate (SGR) = 100 x (lnWt - ln W0) / t (% BW/d)
- Relative Growth Rate (RGR) = (Wt -W0)/ t /BW) (g/ kg/.d)
- Protein efficiency ratio (PER) = Total weight gain (W) / amount of protein fed (g)
- Daily Weight Gain (DG) = (Wt – W0) / number of experimental days (g day^{-1})

Statistical analysis

One-way ANOVA was used to compare the effects of dietary protein level on the performance and feed utilization. When a significant effect was found, Duncan'stest for multiple comparisons of means was performed. The data are presented as mean±SD of the replicate groups. All statistical analyses wereconducted using SPSS version 2.0 and were assessed at a significance level of $p< 0.05$.

RESULTS AND DISCUSSIONS

Water quality

All the water parameters (Mean±SD) were suitable for the rearing of common carp (water temperature – 20.70±0.82°C, dissolved oxygen – 7.93±0.27 mg L^{-1}, pH – 7.93±0.09 pH units, nitrites – 0.06±0.02 mg L^{-1}, nitrates 18.11±3.59 mg L^{-1} and ammonia 0.13±0.07 mg L^{-1}), and were notsignificantly affected by the dietary-protein levels (ANOVA, $p> 0.05$).

Growth performance

The growth performance data of fry carp fed thediets containing various protein levels for 31 days is presented in Table 2.

The initial mean weight of the carpfrywas not significantly different($p>0.05$) for each group.

Survival of each group was over than 95%, and there was no significant difference among treatments ($p > 0.05$).

Table 2. The growth rate and feed utilization of carp fry fed at different levels of protein

Parameters	V1	V2	V3	V4
Initial biomass (g)	597.50±7.95	595.00±4.24	593.00±0.0	595.50±3.54
Final biomass (g)	914.50±7.78	1110.00±31.11	1142.50±27.58	1227.50±45.96
The initial number of fish	200	200	200	200
Total weight gain (g)	317.00±12.73^{a}	515.00±35.36^{b}	549.50±27.58^{b}	632.00±49.50^{c}
Survival (%)	95.25±0.35^{a}	98.75±1.77^{a}	96.25±1.77^{a}	95.75±3.18^{a}
Mean initial weight (g fish^{-1})	2.99±0.02^{a}	2.98±0.02^{a}	2.97±0.00^{a}	2.98±0.02^{a}
Mean final weight (g fish^{-1})	4.80±0.06^{a}	5.62±0.06^{b}	5.93±0.03^{c}	6.41±0.03^{d}
Daily biomass growth rate (g day^{-1})	10.23±0.41^{a}	16.61±1.14^{b}	17.73±0.89^{b}	20.39±1.60^{c}
Individual weight gain (g fish^{-1})	1.81±0.08^{a}	2.64±0.08^{b}	2.97±0.03^{c}	3.43±0.04^{d}
FCR	2.74±0.11^{a}	1.69±0.12^{b}	1.58±0.08^{b}	1.38±0.11^{c}
SGR (% day^{-1})	1.37±0.05^{a}	2.01±0.11^{b}	2.11±0.08^{b}	2.33±0.14^{c}
PER	1.220±0.05^{a}	1.35±0.09^{a}	1.41±0.07^{a}	1.46±0.11^{a}

(Mean value of 2 replicates ± SD); mean values in the same raw with different superscript are significantly different (p<0.05)

The final weight of the fish, Weight gain, specific growth rate (SGR%) and feed conversionratio (FCR) were found to be significantly affected (p<0.05) with the increase of dietary protein level in the diets, while the protein efficiency ratio (PER) showed no significantly different (p>0.05) between the four experimental variants.

At the end of the experiment, significant differences (p<0.05) were registered in the final weight. The lowest individual weight was obtained in the 30% crude protein, and the highest weight was recorded in the 50 % crude protein.

The statistic comparison of the final fish weight (Duncan test) emphasizing four distinct groups of individuals based on their weight. Thus, in V1 variant, the mean individual final weight was 4.80±0.06g fish^{-1}, in V2 5.62±0.06g fish^{-1}, in V35.93±0.03 g fish^{-1}, respectively 6.41±0.03 in V4 (Figure 1).

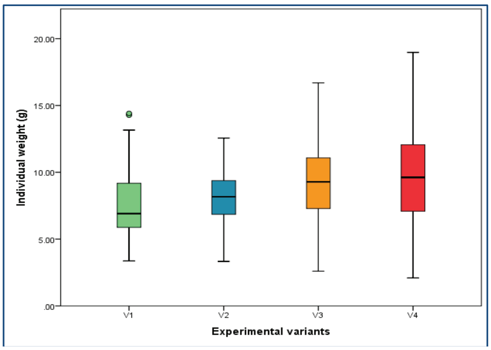

Figure1. The variation of the average individual weight – median, minimum, maximum values and quartiles registered at the end of the experiment for all experimental variants

The maximum weight gain for carpwas obtained with the diet containing 50% dietary protein level and was significantly different (p<0.05) from that achieved by the fish fed a 45%, 44%, and 30% protein diet.

Regarding the feed conversion ratio (FCR) it was observed a significantly decreased as the dietary protein level increased, and ranged from 2.74 to 1.38. The best FCR was obtained atV4 (50% crude protein), followed by V3 and V2 (45% and 44% protein diets), with no statistically significant differences among these two experimental variants (p>0.05).

Significant differences (p<0.05) were recorded in the daily biomass growth rate, and ranged from 10,23 g day^{-1} in V1 case, to 20.39g day^{-1} in the V4.

The specific growth rate (SGR) of frycarp fed varying levels of dietary protein showed a significantly increasing tendency with increasing dietary protein level (p<0.05).

So, SGR was found as 1.37±0.05, 2.01±0.11, 2.11±0.08, 2.33±0.11 % day-1 for V1, V2, V3, and V4, respectively.

According to Lovell (1989), dietary protein is considered to be of crucial importance in fish nutrition and feeding. Therefore sufficient supply of dietary protein is required for rapid growth.

In the present study, the increasein the levels of dietary protein contenthad a significant effect on the growth rate, feed conversion ratio,and specific growth rate. The growth andconversion efficiencies gradually increased with the increase of dietaryprotein levels from 30% to 50% protein containing diet. The best growth parameters were obtained when fish were fed at

50% protein containing diet, the growth rate being significantlydifferent to those groups that were fed at 30%, 44% and 45% protein diet. This may be due to the increase in protein utilization and digestibility with the increase indietary protein level up to 50%.

These findings are in agreement with those obtained by other authors. Dabrowski (1977) foundthe highest gain at grass carp at the optimum dietary protein level (45,56%). In a recent study Khan and Maqbool (2017) reported that the optimum dietary protein level for optimum growth and efficient feed utilization for *Cyprinus carpio var. specularis*, (with the mean, weight, and length of 1.50 ± 0.02 g; 4.5 ± 0.05 cm), is 41.5%. Also, Aminikhoei (2015) conducted a study for Israeli carp (average body weight, 1.3 ± 0.02 g) in order to determine the optimal dietary protein levels (20, 30, 40, and 50%), and found that the diet containing 40% crude protein is optimal for the growth and effective protein utilization. Also, others studies conducted to determine the dietary protein requirements of common carp reported dietary protein requirements ranging from 30% CP in the case of pond-reared fish and fry to over 45% CP in the case of fry and fingerlings (Inayat and Salim, 2005).

In a study conducted in ponds, Mocanu (2015), used extruded feed, with 48% crude protein, in the first 30 days of growth (individual weight of fish 1 g), then feed the carp for 90 days with 30% and 35% crude protein and found that growth performance was significantly improved at 48% crude protein and 35% crude protein.

However, the protein requirements among the fish species are influenced by fish size or age, culture conditions, and nutrient interactions in experimental diets such as protein and non-protein energy levels and further studied are needed to determine the optimal dietary protein for every life stage of carp.

CONCLUSIONS

Feed quality directly influences the growth and quality of fish meat. To choose the right feed, an account is taken of both its protein and energy content. In this case of study, the experimental diet containing 50% protein resulted in the best weight gain, specific growth rate and feedconversion ratio for the fry carp, with the mean weight between 2.9 and 7 g.

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