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SOME ASPECTS ON ORNAMENTAL JAPANESE CARP REARING IN AQUARIUMS

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Abstract

Koi carp are descendants of the common carp, Cyprinus carpio. The production of the colored carp – the Japanese "nishikigoi"- presently exceeds in monetary value the production carp as human food. The researches were performed in Aquaculture and Fishing Department laboratory of Food Science and Engineering Faculty from January 8 to June 24, 2014. The experiments were conducted during five experimental periods. During the mentioned periods it was experimented two variants in aquariums with capacity of 150 l provided with independent aeration and filtration units. In V1 variant, an aquarium was populated with 14 koi carp fingerlings with mean initial weight of 5, 35 g/ex. and a total biomass of 75 g. In V2 variant, another aquarium was populated with koi carp fingerlings with mean initial weight of 29, 28 g/ex., respectively a total biomass of 205 g. Water temperature, dissolved oxygen and pH were measured every day with portable instruments. For feeding fish it used Nutra T (V1 variant) and Nutra 2.0 (V2 variant) pellets. At the end of experiments, mean final weight reached 1570 g for V1 variant and 1446 g for V2 variant.

Key words: *aquarium, koi carp, pellets, rearing.*

INTRODUCTION

The common carp (*Cyprinus carpio*, L.) belongs to the *Cyprinidae*, the largest freshwater teleost family, and is probably the oldest and most extensively cultured fish species in the world (Mondol et al., 2006). This fish has been acclimatized to a wide range of habitats and environmental conditions and therefore enjoys a world-wide distribution.

The colorful koi, or fancy, carp was developed in Japan for ornamental purposes, probably from color mutant types arising in the wild carp (Magoi) of Central Asia (McDowall, 1989). Other commercial stocks (e.g. gold, red and white, tricolour etc.) have been established by selective breeding and cross breeding of colour mutants (Purdom, 1993).

This fish is most famous for its beautiful colours that have been developed via selective breeding programmes. There are over 20 different varieties of koi that differ in colour, patterns and type of scales. Successful koi rearing it depends on maintaining of an artificial environment that simulates as closely as possible the natural environment in which koi are to be found. This is no different from traditional tropical fish keeping with which many aspirant koi keepers may be familiar already. Ornamental carp value increases with intensity of skin colour, which is an important quality criterion. The ornamental carp colors are determinate by specifically cells names chromatophores that are situated in the epidermis and in the dermal superior tissue. The feeding pattern, and thus the growth rate of koi depend on many factors, such as water temperature, water quality, stocking density and genetic background. Koi feed most actively at temperatures in excess of 15^{o}C (59F), thus sexually immature fish can grow rapidly during the summer months when the temperature is warmer (http://www.lagunakoi.com/Koi-Food/Nijikawa-Koi-Food-p-758.html).

Once koi are mature, their growth rate slows considerably; in sexually mature fish, most of the food eaten is utilized in producing eggs or sperm in preparation for breeding. However, unlike many other vertebrates, fish continue to grow throughout their lives and it is easy for koi to reproduce and continue to grow because of their artificially high feeding rates.

The average life span of a koi fish is 15 to 20 years. Some can live up to 30 years or more.

MATERIALS AND METHODS

The study was conducted in two aquariums with a capacity of 150 litres each, provided with independent aeration and filtration units.
In V1 variant an aquarium was populated with 14 koi carp fingerlings with mean initial weight of 5, 35 g/ex., and a total biomass of 75 g. They were brought from Natural Science Museum of Galati where hatched in September 2013.
The fish were fed with Nutra T pellets with crude protein of 52%. Daily feeding rates decreased from initially 5% to 1.5 % of the total fish biomass.
In V2 variant another aquarium was populated with 7 koi carp fingerlings with mean initial weight of 29, 28 g /ex. and a total biomass of 205 g. In this variant the fish were fed with Nutra 2.00 pellets with crude protein of 54%. Daily feeding rates decreased from initially 3% to 1% of the total biomass.
The fish were fed four times / day. Dry feed was dispensed on the surface manually and it was completely consumed by the fish. The pellets contain fish meal, cereal and cereal by-products, oils, antioxidants (BHT). The biochemical composition is presented in the Table 1.

Table 1. Biochemical composition of pellets

Biochemical composition	UM	V1 (Nutra T)	V2 (Nutra 2.0)
Crude protein	%	52	54
Crude fat	%	20	18
Crude cellulose	%	1	0.6
Ash	%	10	10
Phosphorus	%	1.4	1.45
A vitamin	U.I./kg	18000	16000
D3 vitamin	U.I./kg	1800	2300
E vitamin	mg	500	500
Copper ($CuSO_4$)	mg	4.5	5

For the water filtration it was used pomp with capacity of 500 l/h, made in Italy."Aquaclear" pumps have been chosen because they are suitable for low storage density and provide superior filtration, biological, mechanical and chemical. The size of the sponge and the carbon particles provide a large surface that increases the filtering capacity.
Sponges can be easily washed and reused, allowing for the conservation of colonies of biological bacteria. Effective carbon removes dissolved organic compounds, drug substrates and colorants.
Ceramic components provide an environment conducive to the growth of colonies of bacteria that convert ammonia and nitrites into nitrates. We mention that washing the sponge was done with the dechlorinated water, in order not to affect the colonies of bacteria.
In order to maintain good water quality, faeces were siphoned every day. Every three days 20% of total volume of water was changed.
In both experiments, the survival rate was 100%. The temperature, *p*H and dissolved oxygen were monitored every day.
The following equipment was used to measure the water quality parameters: oxygen concentration and temperature were measured with the WTW Oxi 315 I, *p*H was measured with the *p*H meter WTW, model *p*H 340.
Data on fish growth were recorded every month. Growth was determined in term of net weight gain and specific growth rate.
At the end of the experiment the fish were weighed, based on which the following parameters were calculated:

- Weight Gain (W) = Final Weight (Wt) – Initial Weight (W0) (g)
- Feed intake = amounts of feed supplied – uneaten feed.
- Food Conversion Ratio (FCR) = Total feed (F) / Total weight gain (W) (g/g)
- Specific Growth Rate (SGR) = 100 x (lnWt– lnWo) /t (%BW/d)
- Protein efficiency ratio (PER) = Total weight gain (W) / amount of protein fed (g)

RESULTS AND DISCUSSIONS

A high biological feed efficiency can only be guaranteed by an appropriate ratio between the quality and quantity of the feed on the one hand and the physiological requirements of the fish body in nutrients on the other.
In carp, crude protein from fodder ranges within fairly wide ranges, between 25 and 45% depending on age.
These values are also influenced by the growth system and financial resources.
For intensive and superintensive systems, where water is a simple physical substrate,

without natural food, it is necessary to choose a diet rich in protein (Oprea and Georgescu, 2000). So, in this experiment crude protein was 52% in V1 variant and 54% in V2 variant, respectively.

The experiments were running over 167 days between 8th January and 24th June 2014. The water quality parameters monitored were within the tolerable limits for koi carp.

Water temperature ranged from 18.5°C to 25°C for V_1 variant and from 18.5°C to 24°C for V_2 variant (Figure 1); pH from 7.3 to 8.2 for V_1 variant and 7.2 to 8.2 for V_2 variant (Figure 2); dissolved oxygen, from 2.3 to 6.8 ppm from V_1 variant and 2.5 to 5.7 ppm for V_2 variant (Figure 3).

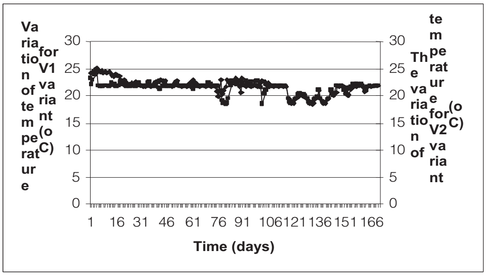

Figure 1. Variation of temperature for both experimental variants

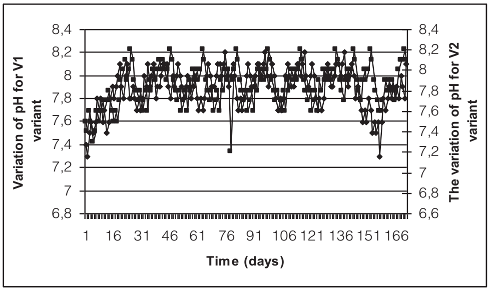

Figure 2. Variation of pH for both experimental variants

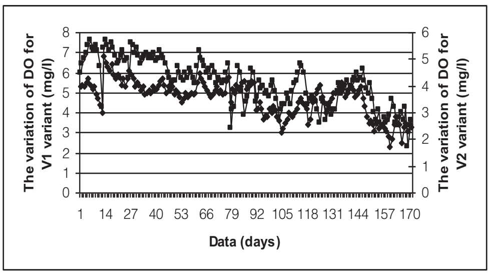

Figure 3. Variation of dissolved oxygen for both experimental variants

In Figure 4 is presented growth rate evolution for both experimental variants during this five experimental periods.

All experimental data regarding fish growth performance are resumed in the Table 2.

Regarding FCR, the best value (0.73) was registered in V1 variant during the second period, when the feeding level was 3% BW g/day.

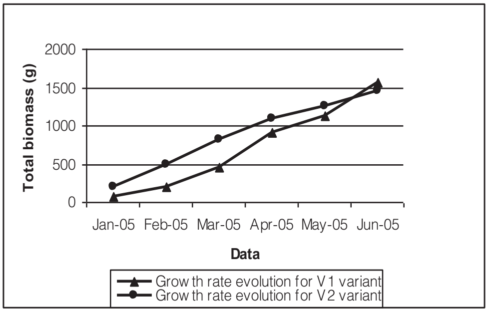

Figure 4. Growth rate evolution for both experimental variants

The feed conversion ratio is an indicator that is commonly used in all types of farming, as well as in the field of research. It can provide a good indication of how efficient a feed or a feeding strategy can be.

The maximum value of FCR (2.7) was register in V2 variant during the fourth period, when the feeding level was 1.5.

In terms of PER (protein efficiency ratio) the best result (2.63) was obtained for V1 variant in the second period.

Regarding individual gain, it can be observed that in the second period the fish from V2 variant showed the best growth of 45.29 g.

Different environmental factors play an important role in the growth and survival of fish. Temperature is probably the most important abiotic factor affecting fish life.

Feeding, digestion and food conversion activities are strongly influenced by ambient temperature, which ultimately reflects the variation in growth rate.

Temperature affects the rate of food digestion by influencing digestive enzyme activity.

The optimal temperature required for growth and other physiological activities varies greatly depending on the species.

Each species has an optimal growth temperature that is probably determined by the optimum temperature for specific enzyme activity. Ornamental carp tolerates a fairly high temperature range between 3-32^{0}C.

At optimal temperatures, fish grow faster, efficiently convert food, and are relatively more resistant to disease (MasserM., 1999).

The variations in fish growth and survival could be due to rearing densities and not the water quality.

However, the mechanisms linking rearing density and growth are not fully understood, but it is generally accepted that when water quality is not affected by the increased number of fish per cubic meter and sufficient food is provided, differences in growth performances could be attributed to the onset of hierarchies and dominant relationship (Usandi et al., 2019). Specific stocking density can have positive and negative effects on fish growth and survival, knowing the optimal stocking density is one of the basic factors influencing intensive fish culture. Fish stocking density is the most sensitive factor determining the productivity of a culture system as it affects growth rate, size variation and mortality (Kaiser et al., 1997).

An important factor to ensure good fish production is water pH.

The optimum pH range differs among species; however, the pH 6.5-9.0 range is generally accepted for fish culture (Heydarnejad, 2010).

Table 2. The growth parameters for both variants during five experimental periods

Parameters	First period		Second period		Third period		Fourth period		Fifth period	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Biomass stocked (g)	75	205	198	488	461	810	912	1091	1135	1263
No. fish stocked	14	7	14	7	14	7	14	7	14	7
Mean initial fish weight (g/fish)	5.35	29.28	14.14	69.71	35.46	115	65.14	155.9	81	180.5
Biomass harvested (g)	198	488	461	810	912	1091	1135	1263	1570	1446
No. fish harvested	14	7	14	7	14	7	14	7	14	7
Survival (%)	100	100	100	100	100	100	100	100	100	100
Mean final fish weight (g/fish)	14.14	69.71	35.46	115	65.14	155.6	81	180.5	112.1	206.6
Individual fish gained (g)	8.79	40.43	21.32	45.29	29.68	40.85	15.86	24.65	31.14	26.07
Total biomass gained (g)	123	283	263	322	451	281	223	172	435	183
Feeding level (%)	5	3	3	2	3	2	2	1.5	1.5	1
Total feed given per aquarium (g)	168	320	192	320	476	612	522	464	510	360
FCR (g/g)	1.37	1.13	0.73	0.99	1.06	2.18	2.34	2.70	1.17	1.97
Growth rate (g/kg/d)	0.2	0.96	0.66	1.41	0.87	1.2	0.54	0.85	1.03	0.86
SGR (% BW/d)	2.3	2.07	2.65	1.56	2	0.88	0.75	0.51	1.06	0.43
Protein efficiency ratio (PER)	1.4	1.63	2.63	1.86	1.5	0.85	0.82	0.68	1.64	0.94

According to Al-Hafedh (1999) growth rate of fish increases with increase in the level of dietary protein till the optimum level is reached. Jana and Chakrabarti (1993) suggest that growth, reproductive potentials, and survival of each species are affected by the nutrient conditions of the culture media.

In the present study the experiment was conducted in closed condition in the aquaria that were different than any natural environment. Hashem et al. (1997) conducted an experiment on *Cyprinus carpio* using different food ingredient having a protein level of about 25% for all feed in floating pellets.

They concluded that optimum weight and length of 24.52 g and 8.07 cm, respectively for six months rearing against the initial weight and length were 5.94 g and 3.76 cm, respectively.

The variation may be due to experimental period because they conducted the experiment for six months and the present study was limited within 167 days (Mahfuj et al., 2012).

The level of dissolved oxygen in water is one of the most important parameters in determining its quality, because it indirectly indicates whether there is some kind of pollution.

The dissolved oxygen depends on water temperature, dissolved salts, atmospheric pressure (and therefore of altitude), the presence of reducing compounds, suspended matter, and living species.

In this experiment, at each aquarium level, air pressure was introduced through Elite 402 pumps to provide an adequate level of dissolved oxygen in the process water.

CONCLUSIONS

The experiments indicated that feeding fingerlings of koi carp with diets containing over 50% protein result in a higher growth response.

Utilizing a ratio which ranges between 2-3% BWg/d it was obtained 26-39% weight gain and FCR of 0.7-1.13.

During the period of experiment, it wasn't registered mortalities; the fish were adapted very well to the aquariums conditions.

In the ornamental carp nutrition it is recommended the colors mention through permanently utilization of natural sources or pellets richer with colors additives, which have a precise and predictable effect.

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