Scientific Papers. Series D. Animal Science. Vol. LXIV, No. 1, 2021
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

THE INFLUENCE OF THE DENSITY OF JUVENILE CARP RAISED IN FLOATING CAGES ON THE CONVERSION EFFICIENCY OF FEED

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Abstract

Fish is an important part of human nutrition, with high biological value, easily digestible, without unfavourable effects to human health. Fish consumption is expected to increase by at least 20% in the next years. Increasing the amount of fish meat can be achieved by intensive aquaculture. The current paper presents a comparative analysis of the results obtained in the intensive growth in floating cages of juvenile carp intended for human consumption at different growth densities. As a result of the experiment, fish that grow at a density of less than 15 kg/m^3 have a lower feed conversion ratio and a higher weekly average growth rate than carp raised at a density higher than 15 kg/m^3.

***Key words**: carp, density, feed conversion ratio (FCR), growth, meat.*

INTRODUCTION

Fish aquaculture is the main sector of aquaculture and its objectives are breeding and harvesting of fish species suitable for human consumption (Diaconescu, 2003). The fish breeding takes place in controlled conditions where differentiated technologies are applied specific to each species function of their characteristics (Nicolae et al., 2015). Fish aquaculture can be developed in various conditions like natural ponds or lakes (extensive or semi-intensive aquaculture), in man-made structures (artificial ponds, reservoirs, channels) either extensive or intensive on floating cages Pricope et al., 2012). The floating cages were developed extensively in the last 30 years and now can be find on open seas not only in protected areas near the shore (Cardia & Lovatelli, 2015). Also, a big development happened in the last 20 years with indoor aquaculture for species that have a good market price or for endangered species where breeding programmes were required (Lehmköster, 2013).

The accelerated depletion of wild fish stocks is a consequence of overfishing, lack of sustainable management (fish caught under correct dimensions), climate change, breeding area destruction, high levels of pollution, etc (Jardim et al., 2020; Stavrescu-Bedivan, 2015).

Because the above-mentioned factors the specialists are trying to develop new technologies aimed to increase aquaculture production at sustainable costs, with emphasis on food security and quality with regard to animal welfare.

MATERIALS AND METHODS

In the present study, we realised a comparative analysis of results obtained for intensive carp growth in floating cages on Mihailesti Lake at various stocking densities. The aim of our work was to determine the right balance between density, feed consumption and overall weight gain in a determined period.

The fish used in our survey is carp juveniles from the farm with an average weight of 187 grams. The fish were distributed on two cages at the end of September as it follows:

- Cage 1 - 35,515 juvenile fish;
- Cage 2 - 26,438 juvenile fish.

The overwintering period started at the end of October and finished at mild-April. After the overwintering period, a first grading and counting took place (Figure 1). The fish was redistributed in six cages as it follows:

- Fish from cage 1:
    - Cage 1.1. - 12,625 pcs;
    - Cage 1.2. - 11,100 pcs;
    - Cage 1.3. - 6,798 pcs.
- Fish from cage 2:
    - Cage 2.1. - 9,837 pcs;
    - Cage 2.2. - 9,189 pcs;
    - Cage 2.3. - 5.798 pcs.

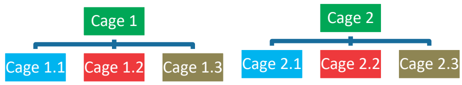

Figure 1. Cage division scheme (compared cages are represented by the same colour)

In order to establish the growth dynamic of carp juveniles were fed with the same type of food for 10 weeks until the end of June. After this period, the lots were compared through results analysis. The fish were weight before being distributed on cages and after the redistribution, respecting the actual norms and legislation. The weighting was done with an electronic scale through sampling. For each cage we sampled three times 50 pcs each time. The average weight was establish dividing each weight to fifty and then we accounted for the total of the averages and dived to three. The losses were accounted for by counting and weighing the total of the dead fish during the period. The resulted data was analysed establishing the average, standard deviation, variability coefficient, and the average error. The results significance was tested with the Student test.

RESULTS AND DISCUSSIONS

The feed used in the research period was imported from EU country. For feeding the following factors were taken in account fish weight and water temperature. Function of water temperature the number of feeding sessions can vary from one to five; the optimum period between each meal is directly dependent on water temperature. The minimum period in between meals was there hours (Table 1 and Table 2).

Table 1. Number of meals by temperature

Water temperature	12˚C	14˚C	16˚C	18˚C	20˚C	22˚C	24˚C	26˚C	28˚C	30˚C
Number of meals	1	1	1	2	3	4	5	4	3	2
Time of meal administration	11:00	11:00	11:00	10:00	08:00	07:00	07:00	07:00	08:00	10:00
				14:00	13:00	11:00	11:00	11:00	13:00	14:00
					18:00	15:00	14:00	15:00	18:00	
						19:00	17:00	19:00		
							20:00			

Table 2. Recommended feed level, kg feed per 100 kg fish/day

Specification		Water temperature									
Fish weight (g)	Granulation (mm)	12˚C	14˚C	16˚C	18˚C	20˚C	22˚C	24˚C	26˚C	28˚C	30˚C
100-300	2	0.75	1.26	2.01	3.02	3.77	4.52	5.03	4.52	4.02	3.02
300-750	4	0.60	1.01	1.61	2.41	3.02	3.62	4.02	3.62	3.22	2.41
750-1500	6	0.48	0.80	1.29	1.93	2.41	2.90	3.22	2.90	2.57	1.93
>1500	8	0.39	0.64	1.03	1.54	1.93	2.32	2.57	2.32	2.06	1.54

The feed should have the following qualities:
- good floatability (fish got accustomed to eating at the surface of the water);
- to have broad spectrum of nutrients as the fish doesn’t have any other source of food;
- the packaging should be resistant in order not to break during manipulation and loses to be avoided;
- the storage facility should protect from direct sun and high temperatures.

The feed used has a broad spectrum of components like blood meal, fish meal, rapeseed seed oil, soja extract protein, sunflower extract protein, vitamins, minerals, fibres etc. The gross protein content in feed is 30%, gross fat 7%, fibres 5.5%. The digestible energy is 12.6 MJ for pellets above 2 mm.

After the first distribution Cage 1 was populated with 35.515 pcs of fish with an average weight of 90 grams with a density of 18 kg/ m^3 density while Cage 2 was populated with a number of 26438 pcs of fish with an average weight of 90 grams and a 14 kg/m^3 density. After the overwintering period a 14.05% mortality was registered for Cage 1 and 10.26% for Cage 2 the losses being directly related to stocking densities (Figure 2).

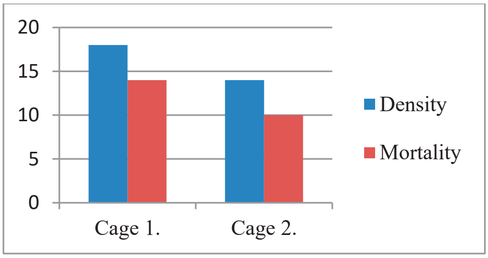

Figure 2. Comparative results on the density and mortality of fish in the two cages

After the overwintering period, the first redistribution of lots took place to be compared after the 10 weeks of feeding.

Cage 1.1. was stocked with 12,625 pcs with an average weight of 120 grams at a density of 7 kg/m^3, Cage 2.1. was stocked with 9,837 pcs with an average weight of 120 grams and a density of 5 kg/m^3. After 10 weeks of feeding Cage 1.1. registered a mortality of 2.3%. The average weight reached 360 g with a feed conversion rate (FCR) of 2.1 using 6,146 kg of feed for a weight gain of 2,927 kg and a final density of 21 kg/ m^3.

Cage 2.1. registered a mortality of 1.7%. The average weight reached 380 grams with a FCR of 1,8 using 4491 kg of feed for a weight gain of 2,495 kg and a final density of 15.8 kg/m^3 (Figure 3).

Cage 1.2 was stocked with 11,100 pcs with an average weight of 200 grams at a density of 8 kg/m^3, Cage 2.2 was stocked with 9,189 pcs with an average weight of 200 grams and at a density of 6.5 kg/m^3.

After 10 weeks of feeding Cage 1.2. registered a mortality of 2.5%. The average weight reached 570 grams with a feed conversion rate (FCR) of 2 using 8,186 kg of feed for a weight gain of 4,093 kg and a final density of 18.5 kg/m^3.

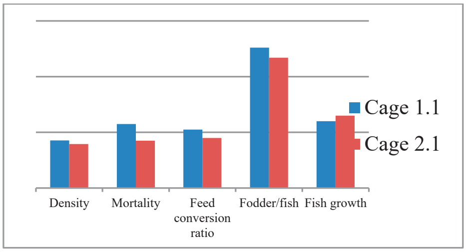

Figure 3. Comparative results between cages 1.1. and 1.2.

Cage 2.2. registered a mortality of 1.8%. The average weight reached 600 grams with a FCR of 1.9 using 6,798 kg of feed for a weight gain of 3,578 kg and a final density of 18 kg/m^3 (Figure 4).

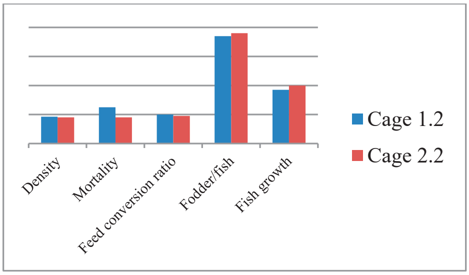

Figure 4. Comparative results between cages 1.2. and 2.2.

Cage 1.3. was stocked with 6,798 pcs with an average weight of 350 grams at a density of 9 kg/m^3, Cage 2.3. was stocked with 5,798 pcs with an average weight of 350 grams and a density of 4.5 kg/m^3.

After 10 weeks of feeding Cage 1.3. registered a mortality of 2.5%. The average weight reached 880 grams with a feed conversion rate (FCR) of 2 using 6,912 kg of feed for a weight gain of 3,456 kg and a final density of 22.5 kg/m^3.

Cage 2.3. registered a mortality of 1.5%. The average weight reached 1.100 grams with a FCR of 1.6 using 6,806 kg of feed for a weight gain of 4,254 kg and a final density of 14.13 kg/m^3 (Figure 5).

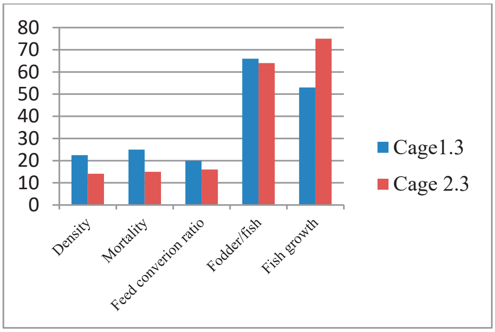

Figure 5. Comparative results between cages 1.3. and 2.3.

The results obtained for carp juveniles growth for a 10 weeks' period on floating cages were evaluated with Student test from relevance perspective.
The lots comparison started from the first stage meaning from the distribution in the 2 cages. The averages for the 2 cages were compared following the three parameters (number of fish, mortality and feed quantity).
As it can be seen in Table 3 for the number of individuals a significant difference was observed but was normal keeping in account that the initial difference was 7,000 pcs.

Table 3. Testing the significance of the results obtained in the formation of the starting cages (1 and 2)

Character		Cage1	Cage 2	t Calculated	t Tabular	Level of significance
Fish number	Average	34455.75	26787.00	17.46	2.57	S
	Variance	536575.58	234996.67			
Mortality	Media	3.85	2.65	0.49	2.57	INS
	Variance	17.80	6.59			

After the feeding period, we analysed the results from cages 1.1. and 2.1. with the Student test and we found significant differences only from number of fish point of view, app 2,500 pcs (Table 4).
Analysing the two cages from mortality point of view we can say that the results obtained are homogenous from averages perspective with a calculated value of 0.68 in comparison with 2.11 the table value. Regarding the weight there are no significant differences, the groups are homogenous although a high difference in number of pcs per cage is registered. As it can be observed in Table 4 the calculated value for the feed quantity was 0.27 compared with 2.1 the table value; it means that from average feed consumption perspective both cages are homogenous.
Analysing the next set of cages 1.2. and 2.2. which were created after the first grading we can observe a consistency in the results with significand variations only from number of fish perspective, app 2,000 pcs (Table 5). The value calculated for the weight of carp juveniles was 1.21 while the table value is 2.12 so we can assess that the two groups are homogenous from weight point of view. The last two indicators analysed are feed quantity and mortality where we didn't register significant variations, meaning that the groups are homogeneous.

Table 4. Testing the significance of the results obtained after the feeding period for cages 1.1. and 2.1.

Character		Cage 1.1	Cage 2.1	t Calculated	t Tabular	Level of significance
Growth	Average	0.207	0.239	0.800	2.120	INS
	Variance	0.006	0.010			
Fish number	Average	12029.500	9550.300	30.230	2.160	S
	Variance	55429.833	11830.455			
Mortality	Average	0.662	0.385	0.686	2.110	INS
	Variance	1.128	0.498			
Feed quantity	Average	500.700	465.400	0.275	2.101	INS
	Variance	77034.456	87990.711			

Table 5. Testing the significance of the results obtained after the feeding period for cages 1.2 and 2.2

Character		Cage 1.2	Cage 2.1	t Calculated	t Tabular	Level of significance
Growth	Average	0.207	0.239	0.800	2.120	INS
	Variance	0.006	0.010			
Fish number	Average	12029.500	9550.300	30.230	2.160	S
	Variance	55429.833	11830.455			
Mortality	Average	0.662	0.385	0.686	2.110	INS
	Variance	1.128	0,.498			
Feed quantity	Average	500.700	465.400	0.275	2.101	INS
	Variance	77034.456	87990.711			

Table 6. Testing the significance of the results obtained after the feeding period for cages 1.3 and 2.3

Character		Cage 1.3	Cage 2.3	t Calculated	t Tabular	Level of Level of significance
Growth	Average	0.484	0.525	0.657	2.110	INS
	Variance	0.015	0.024			
Fish number	Average	6727.700	5539.300	117.502	2.110	S
	Variance	615.344	407.567			
Mortality	Average	0.116	0.117	0.007	2.110	INS
	Variance	0.120	0.078			
Feed quantity	Average	595.800	609.000	0.088	2.101	INS
	Variance	106778.178	115926.889			

As it can be seen in Table 6 there is a significant variation in fish numbers but which is normal as the cages were stocked with app 1000 pcs difference from the beginning of experiment.

Analysing the two cages from mortality point of view we can observe a calculated value of 0.007 in comparison with 2.11 the table value.

This shows that from an average mortality perspective the cages are homogenous. The feed quantity used is similar which again shows homogeneity between the two lots. The average value calculated for carp is 0.65 while the table value is 2.11 which shows homogeneity between the two lots. (Table 6).

CONCLUSIONS

After the research done and the results obtained regarding the technology of carp growth in floating cages the following conclusions emerged:

- the fish density should not exceed 15 kg/m^3 in order to minimize the stress, mortality rates and disease risk;
- the fish grown in densities smaller than 15 kg/m^3 have a bigger growth rate, a better FCR, lower than 2, the economics being significantly improved;
- a lower density generates a more uniform growth between individuals, while a bigger density creates an uneven growth with significant number of fish underdeveloped;
- the fish which are more likely to get diseases are those under one year old.

ACKNOWLEDGEMENTS

This research work was a part from the PhD thesis of Anin Ionut Alexandru - “The influence of thinning and subdivision on carp for consumption increased in floating ponds”, and was carried out with the support of Faculty of Engineering and Management of Animal Production, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Pelicanul Distribution carp farm (Giurgiu County) and Romanian Fish Board.

REFERENCES

Diaconescu, S. (2003). *Fish culture*. Bucharest, RO: USAMV Editorial Centre.

Cardia, F., & Lovatelli, A. (2015). *Aquaculture operations in floating HDPE cages. A field handbook*. FAO Fisheries and aquaculture technical paper, 593. Rome, IT: Food and Agriculture Organization of the United Nations and Ministry of Agriculture of the Kingdom of Saudi Arabia. Retrieved October 9, 2020, from http://www.fao.org/3/i4508e/i4508e.pdf.

Jardim, E., Pinto, C., Mannini, A., Vasilakopoulos, P., & Konrad, C. (2020). *Scientific, Technical and Economic Committee for Fisheries (STECF) - Monitoring the performance of the Common Fisheries Policy (STECF-Adhoc-20-01)*. Luxembourg, LU: Publications Office of the European Union. doi:10.2760/230469, JRC120481.

Lehmköster, J. (2013). *A bright future for fish farming*. Hamburg, DE: WOR 2 The Future of Fish - The Fisheries of the Future, chapter 4. Retrieved October 12, 2020, from https://worldoceanreview.com/wp-content/downloads/wor2/WOR2_en_chapter_4.pdf.

Nicolae, C.G., Grosu, H., Bahaciu, G., Marin, M., Raducuta, I., & Moga, L.M. (2015). Optimization of the selection indices using two characters in cyprinids population of Ropsa breed, for increasing the meat production. *Journal of Environmental Protection and Ecology*, (16)3, 955–959.

Pricope, F., Battes, K., & Stoica I. (2012). *The biological bases of aquaculture*. Bacau, RO: Alma Mater Publishing House.

Stavrescu-Bedivan, M.M., Vasile Saceteanu, G., Madjar, R.M., Matei, P.B., & Toba, G.F. (2015). Comparative study of length-weight relationship, size structure and Fulton's condition factor for Prussian carp from different Romanian aquatic ecosystems. *AgroLife Scientific Journal*, 4(2), 132–139.