

Environmental Conditions Assessment for the Carp Cultured in Floating Cages on the Irrigation Canals

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Abstract

Aquaculture in cages is considered an alternative to fishing in natural waters, by increasing fish production and using new water resources. This production method confers efficiency for fish farming and varies according to the ecological quality of the body of water used, its depth, and its potential for renewal. Integrated aquaculture in irrigation canals is a relatively new technological concept, used to maximize water efficiency by designing and placing removable fish raising facilities and establishing cages fish farming technologies, located on small bodies of water such as irrigation canals. The experiment was conducted over 30 days. The biological material for the floating cages has been represented by common carp with a body mass average of 453 g. A number of 450 carp specimens were distributed in a floating cage with a size of 5m×3m×3m made of galvanized panels. Results from the analysis of the gained weight was the 56.88 kg, with an initial fish loading weight per cage cubic meter of 5.43 kg/m³ and a finally result of 6.95 kg/m³ carp. In conclusion, the *Cyprinus carpio* species is of great interest for raising in floating cage located on the irrigation canal, because it supports a high level of adaptability and technological plasticity suitable for aquaculture.

Keywords: carp, cages, irrigation canal

1. Introduction

Cage culture in underutilized water bodies can aid in bridging the demand supply gap of quality animal protein and provide livelihood to resource poor fishers in developing countries [1]. There is an immediate need for diversification with commercially and regionally important species for increased adoptability and profitability of cage culture [2]. Cage culture practices may bring about changes in sedimentary profiles and zoobenthos communities beneath cage farms [3-5].

Submergence may solve several of the substantial operational challenges that exist in surface-based fish farming, including those related to heavy storms, algal and jellyfish blooms, unsuitable

temperatures, high pollutant levels and biofouling of net cages [6, 7]. Moreover, the high concentration of fish confined in surface net cage systems attracts predators [8], primarily birds (e. g. herons, gulls and cormorants). Predation by fish-eating bird species is a significant problem leading to death and injury in fish, resulting in economic damage to farmers [9, 10].

Presently, about 70 species are being reared in freshwater cages globally, with *Pangasius* being the dominant species accounting to 41.1%, followed by *Oreochromis niloticus* (26.7%), *Cyprinus carpio* (6.6%), *Oreochromis* spp. (5.1%), *Oncorhynchus mykiss* (4.1%) and *Salmo* spp. (3.7%) [11].

Water is becoming increasingly limited due to climate change. There is also growing competition

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for both space and access to water between various economic activities, including aquaculture. In addition, further progress is needed on other aspects of spatial planning and access to water for aquaculture activities [12].

The activity of aquaculture in cages requires first of all the knowledge of the aquatic environment specific to the irrigation canal where the floating fish cages will be located, of some environmental aspects and at the same time the biology of the cultivated species. The main advantages of this technology are: relatively fast recovery of water in cages (depending on their size) without costs; lower initial investments than on land technology; lower frequency of fish health problems; increased fish production (due to the high level of dissolved oxygen in the water stream of irrigation channels that stimulates the metabolism and the assimilation process of fish that materializes in a good growth spurt); increased production of vegetable crop biomass (by feeding it with water loaded with organic substances and nitrogen compounds from fishing activity) and last but not least avoiding environmental pollution by recirculating and using wastewater in the aquaponics system [13].

Romania has a rich network of irrigation canals (2,177.58 km), and Galati County has a network of 175.94 km that so far has never been exploited in fish farming. The experiments proposed in this study have as their main objective the development of techniques and technologies for raising fish

species of high economic value, especially cyprinids (carp as the main species) in irrigation canals.

The objective of this experiment was to evaluate the parameters and conditions for growing common carp (*Cyprinus carpio*) in a floating cage located on the CM Lunca irrigation canal.

2. Materials and methods

The study was conducted from 14 September to 15 October 2021 in the CM Lunca irrigation canal. The biological material represented by the one-year-old carp from the Brateş fish farm of ICDEAPA Galaţi. The common carp (*Cyprinus carpio* Linnaeus, 1785), with a body mass average of 453 grams, was loaded in a cage at a stocking density of 450 fish/cage, respectively 12 fish/m³. A number of 450 carp specimens were loaded into a floating cage with a size of 5 m×3 m×3 m made of galvanized panels, the capacity being 37.5 m³, and the guard above the water is 0.5 m. The galvanized panel cage was made within ICDEAPA Galaţi near of the irrigation canal and has a size of 5 m×3 m×3 m. The available volume is 38 m³, with a protective fence of 0.45 m. The cage was provided floats both inside and outside to ensure its buoyancy. Table 1 shows the materials used to make the experimental cage. The location of the cage on the CM Lunca irrigation canal (photo 1) was done with the help of a motorboat and some ropes.

Table 1. Materials needed to make a carp cage

Material name	Measure unit
Tube 40×20×1,5×6M	piece
Steel tear welding hinge L=60 FI10MM	piece
Spruce dry wood 21×45×4M IV/V NE	piece
NM 6 M6 nut, din 934, 8.6 gram	piece
Galvanized panel 2.5×25×25MM 1×2M	piece
M6 nut	piece
Ciur net	piece
Bridge 6 washer flat Washer m6 from 9021	piece
ZN wire 1.6	kilogram
8×50 rope	kilogram
M6×60 screw	piece
Square tube 25×25×1.5×6M	piece
Autoforant 55×50	piece
Straight tube 40×20×2	piece

Realization of the experimental model of carp raising in the CM Lunca irrigation canal took into account its technical - constructive and functional

characteristics, especially those of the area selected for the development of the related experimental works.



Foto 1. The layout of floating cages for growing carp.

These technical-constructive and functional characteristics refers to:

- the selected area calculated along the length of the canal sector should be at least 0.5 ha;
- the internal slopes of the irrigation canal should not be easily eroded, and the access of unauthorized persons or animals to them should be restricted or even forbidden;
- the working section of the irrigation canal must ensure a water level of at least 1.5-2.0 m on more than 5.000 m of the canal;
- the water level should not fluctuate more than 0.50-0.60 m during the period of

growth and development of the fish;

- the access of specialists, work personnel, and various tools and technological equipment must be ensured by the presence or construction of access roads practicable in any atmospheric conditions.

For this experiment, the feeding intensity was of 3% per body weight per day with three meals per day. Extruded feed (the diameter of the granule was 4 mm) containing 30% crude protein and 9% fat. The feeding of the biological material was done with floating fodder, and the cage was provided with a safety net to keep food losses to a minimum. The biochemical composition of the feed used is presented in the table no. 2.

Table 2. The biochemical composition of *AQUA VITAL SWIM*.

Composition	Quantity
Crude protein %	30,0
Crude lipid %	9,0
Crude cellulose %	3,5
Phosphorus %	1,10
Vitamin A (UI)	10000
Vitamin D3 (UI)	1750
Vitamin E (mg)	175
Vitamin C (mg)	165
Digestible energy (MJ/kg)	16,3

The assessment of water quality in the culture system was performed by daily monitoring of temperature, oxygen and pH using portable oxygen meter HACH HQD Field Case 58258-00,

respectively by periodic determination of nitrates, nitrites, ammonium, chlorine and dissolved organic matter by the method colorimetric with the help of the DR 2800 spectrophotometer.

3. Results and discussion

The weight of fish produced in floating cages depend on many factors including the fish species, stocking density, fish size at stocking, culture period, cage size, water quality and feeds used [14]. Water temperature affects fish mortality after stocking. Survival of fish (carp) is best when they are stocked at a water temperature of 15°C or less. The mortality of fish reared in floating cages is generally low if correct practices of culture are adopted [15].

Water quality parameters (temperature and oxygen) were monitored daily, and nitrogen compounds and other chemical parameters weekly. The temperature varied from 12.7 to 21.7°C (figure 1) range which is below the technological optimum of the species (25-28°C); the tendency of the water temperature to decrease towards the end of the experiment is due to the specific climate changes in autumn season. When the water temperature drops below 10°C, the intensity of carp feeding decreases, and at temperatures below 7°C the feeding process stops.

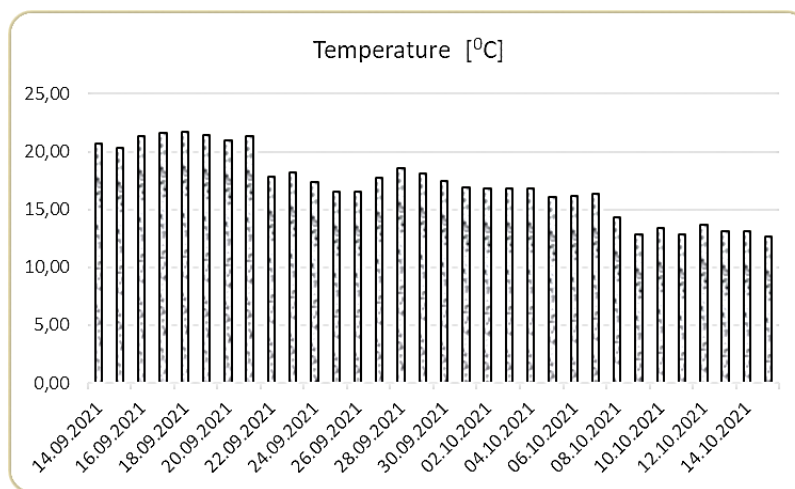


Figure 1. The temperature evolution during the experimental period

The percentage of dissolved oxygen in cold water is higher than in hot water, and in freshwater is higher than in seawater. The dissolved oxygen concentration ranged from the admissible to the optimal values of the carp species. The dissolved oxygen (DO) varied according to environmental conditions in the irrigation canal (mean DO was

7.01±1.06 mg/L), the lower values being registered in the middle of the experimental period (4.95 mg/L). The evolution of this parameter is presented in figure 2.

Also, the nitrogen compounds, chlorine and dissolved organic matter were in the allowable interval for the cultivated fish species (table 3).

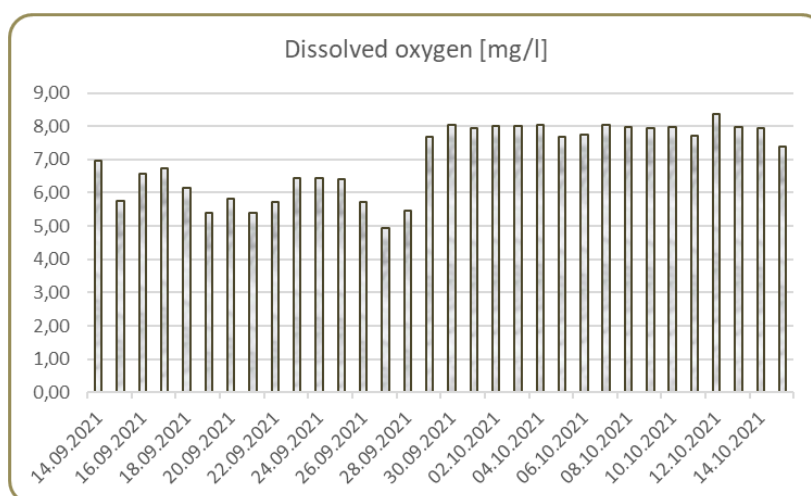


Figure 2. The dissolved oxygen evolution during the experimental period

Aquaculture in cages located on the irrigation canal provides that the working section of the irrigation canal must ensure a water level of at least 1.5-2.0 m for at least 5,000 m span to indicate a space for favorable growth. The water level recorded an

average of 1.58 m during the experiment (figure 3), and is recommended not to show fluctuations greater than 0.50-0.60 m during the period of fish growth, as they influence the entire technological process.

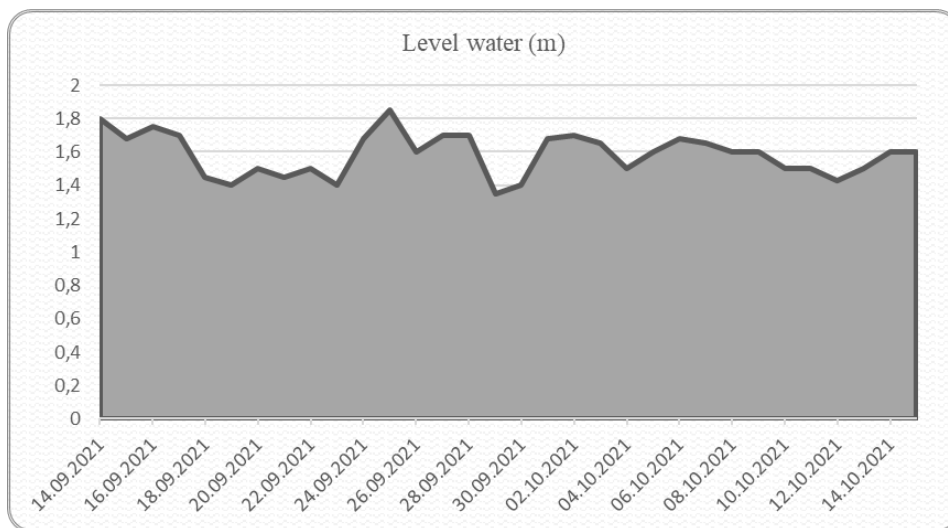


Figure 3. The dynamics water level during the experimental period

Romania has an important potential for fish production represented by accumulation lakes (natural or artificial), ponds, large rivers, high capacity irrigation canals [16]. The Institute for Research and Development in Aquatic Ecology, Fishing and Aquaculture, Galați (I.C.D.E.A.P.A. Galați) experienced the raising of carp in a floating cage. In this regard, raising technologies for the complex exploitation of water column in traditional

fish farms have in mind the placement of intensive growth modules (such as floating cages) on the surface of fish ponds, which would allow obtaining additional quantities of fish on the same unit of water surface and rearing of valuable species (catfish, carp, sturgeon, tilapia, etc.), in the conditions of efficient exploitation of aquatic bioresources [17, 18].

Table 3. The physico-chemical parameters of water in floating cage (CM Lunca - irrigation canal)

The Physico-chemical parameters	Units of measurement	Determined values			Maximum allowed values
		minimum	average	maximum	
pH	units pH	7.23	7.71	8.19	6.5-8.5
Organic matter	mg KMnO ₄ /l	45.11	60.22	75.33	60
Chemical oxygen consumption CCO-Mn	mg O ₂ /l	10.35	13.59	16.84	15
Calcium Ca ²⁺	mg/l	52.10	56.11	60.12	160
Magnesium Mg ²⁺	mg/l	9.40	20.49	31.59	50
Ca ²⁺ /Mg ²⁺	Report	1.90	4.69	7.49	5
Total hardness	°D	13.67	14.68	15.70	20
Nitrites NO ₂ ⁻	mg N/l	0.003	0.012	0.021	0,2
Nitrates NO ₃ ⁻	mg N/l	0.723	0.82	0.920	5
Chlorides Cl ⁻	mg/l	12.54	12.54	12.54	40

Table 4. The table regarding the biotechnological indicators of farmed carp in floating cage

Indicators	Floating cage
Initial number of fish	450
Final number of fish	448
Survival rate [%]	99
Initial biomass [kg]	203.85
Initial biomass [kg/m ³]	5.43
Final biomass [kg]	260.73
Final biomass [kg/m ³]	6.95
Biomass gain [kg]	56.88
Biomass gain [kg/m ³]	1.51
Mean initial weight [g/fish]	453
Mean final weight [g/fish]	582
Individual weight gain [g]	129
Specific growth rate [%/day]	0.82

The survival of the biological material (carp) in the experimental cage was high, especially since fluctuations in medial factors (temperature, oxygen, turbidity, wind speed, etc.) and feed competition played a vital role in the growth and survival of fish. Under the conditions of a low water temperature in the irrigation canal, the growth rate of carp was 56.88 kg, with an individual weight gain of 129 grams. From the analysis of data on biotechnological indicators performed in this experiment, it was found that the level of weight gain of carp in the specific conditions of the irrigation canal (low temperature, optimal dissolved oxygen concentration, water flow, low nitrogen compounds, pH, etc.) is due to an appropriate nutrient uptake rate. Feeding diets consisting from natural food supplemented by fodders, depending on species and fish age, lead to the growth of muscle mass and to protein and lipids accumulation in the detriment of moisture [19]. The study on carp rearing in the floating cage located on the irrigation canal, which has as main source the water of Danube River indicates good results compared to the aquaculture practiced in the earthen ponds.

4. Conclusions

Data on the assessment of carp growth indicators in galvanized cages indicate a favorable ratio between the growth rate and the efficiency of the feeding process of fish by the use of administered food, which ultimately leads to satisfactory results under partially controlled technological conditions (CM Lunca irrigation canal). In conclusion, the *Cyprinus carpio* specie is of great interest for raising in floating cage located on the irrigation canal,

because it supports a high level of adaptability and a technological plasticity suitable for aquaculture. The only inconvenience encountered is the harvesting of biological material.

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