COMMON CARP ADAPTABILITY (*CYPRINUS CARPIO*) TO REARING IN FLOATING FISH CAGES INSTALLED IN IRRIGATION CANAL

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Abstract

With the increases of world fish consumption and stagnation of wild fish catches, the contribution of aquaculture to world fish production has steadily increased from 25.7% in 2000 to 46.8% in 2016. Integration of aquaculture in irrigation canals, respectively dual use of the same water, first for fish production and later for irrigation is a relatively new technological concept, used to maximize the efficiency of water use, by designing and locating removable installations and establishing technologies for rearing fish in small bodies of water (irrigation canals).

The CM LUNCA irrigation canal on which the experiment took place was artificially built in 1969 and serves a very large agricultural area; is part of the irrigation network of Covurlui Plain and is managed by A.N.I.F., Southern Moldova branch. The irrigation system of which C.M.L. is part of, consists of the main pumping station SPA Dunărea, 6 pumping stations SPR, 21 pressure stations SPP, 37 canal motor pumps, 126 km irrigation canals. The Lunca Magistral Canal has a length of 19240 m and stretches from km 78.4 of the Danube from where it makes its outlet, passes behind Lake Brateș and reaches close to Vânători commune. The Danube pumping station is the main station of the Covurlui Plain (S.P.A.) subsystem and takes the water from the Danube river through the gravitational outlet with a flow of 54 mc/s. The distribution of water on the canals is ensured by the main dam, which has three openings with cofferdam and flat dams. The water from the C.M.L. currently irrigates only 5566 ha, located on the first terrace (surface that requires about 3m/s), and the surplus is intended for the upper terraces, which require a pumping height Hp = 90m.

The adaptation of the carp species to rearing in floating fish cages from the CM Lunca canal was made in a time interval between 3 and 7 days from the population of the ponds, at a density of 150 ex/m^3 and a distance from the crown of the dam between 17,5m and 30,5m.

Key words: carp, floating fish cages, irrigation canal, adaptation

INTRODUCTION

The food needs of the population are constantly growing worldwide and thus it is necessary to find new solutions to obtain quality animal protein at the lowest possible price.

According to the FAO, aquaculture is the fastest growing food-producing sector and currently accounts for 50 percent of the world's fish that is used for food. In Europe, aquaculture accounts for about 20% of fish production.

Integrated Aquaculture in irrigation canals is a technological concept relatively new. "*Because the techniques and technologies used in integrated systems are not well documented, the level of productivity and economic status of integrated agricultural systems it's difficult to understand"*. (Ruddle and Zhong, 1988).

According to Edwards (1998), synergies occur when " *an exit from a subsystem of an integrated agricultural system, which could otherwise have been wasted, becomes a contribution to another subsystem, resulting in a higher efficiency of the production of the desired products. land / water area under the control of the farmer"*.

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Cage aquaculture can contribute to the supply of protein for consumption, to employment creations and also increase irrigated agricultural production.

This aim is the basis of the present study, which starts from the principle of integrated fish farming, by using irrigation canal water to growth fish in the pond and also by stimulating agricultural production by watering plants with irrigation water enriched in nutrients resulting from fishing activity.

Globally, this activity is relatively recent and in our country there are no studies in this field. 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.

Because of these aspects, the most important period within this technology is the adaptation of the carp species to the intensive growth in floating fish cages in the specific conditions of the CM Lunca irrigation canal.

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 aquaponic system.

MATERIALS AND METHODS

A period of 30 days was considered for the present experiment. The floating ponds (photo no.1,2) used are 4 in number and each has a capacity of 2 m³. Frame is double HDPE Φ = 200 mm (2 floats) with HDPE railing Φ = 110 mm, number of railing support legs = 4 pcs (Φ = 110mm), connection of HDPE floats (Φ = 250 mm). The netting of the cages for the first stage of carp growth was made of a curtain made of 100% polyester (Φ = 2 mm), cut in a rectangular parallelepiped shape and weighted with weights of 2-5 kg at the lower corners immersed in water, to avoid twisting them. to strong wind but also to allow a correct tension of the net ensuring the photability of the ponds in conditions of fluctuation of the water level on the irrigation canal.

The CM Lunca irrigation canal on which the experiment was carried out was artificially built in 1969 and serves a large agricultural area. C M The meadow has a width of 75 m and a length of 19,240 m and stretches from km 78.4 of the Danube from where it takes in, passes behind Lake Brateș and reaches close to the Vânători township.

CM Lunca is part of the irrigation network in the Covurlui Plain and is managed by A.N.I.F. (National Agency for Land Improvement), South Moldova branch.

The irrigation system of which C.M. Lunca is part consists of the main pumping station SPA Dunărea, 6 SPR pumping stations, 21 SPP pressure pumping stations, 37 canal motor pumps, 126 km of irrigation canals.

CM Lunca is periodically supplied with water depending on the weather and the agricultural needs it serves..

The location of cages was made perpendicular to the channel of the irrigation canal, up to its middle, in order to follow the evolution of the fish material in different current conditions and depths of water.

The cage service pontoon is made of extruded polyethylene PE HDPE, the resistance temperature of the floats -50 / 80ºC and the diameter 200 mm.

The length of the pontoon is 5m, draft 0.3 (m) and the podium of the pontoon is made of fir tree wood.

Photo 1 – Cage 1 and 2 from CM Lunca

Photo 2 Fish cages 1,2,3,4 with pontoon

The biological material used for the experiment was represented by the carp species (*Cyprinus carpio*) with an average mass of 3 g / ex.

Photo 3 Adaptation of carp to water temperature in V1

Photo 4 Population of carp fish cages

Technological indicators are absolutely necessary in order to obtain information on the performance of the applied technology and the growth system. Determination of body indices in fish provides information to the farmer on the body development of the fish, the growth rate, the state of maintenance (welfare) and the adaptability to environmental conditions.

Relative weight gain - (RWG) - was determined gravimetrically, and consisted in weighing two samples at the time of population, determining the initial mass, and two samples, at the end of the analyzed growth period, determining the final mass. It was calculated with the formula: Sr = Bf - Bi [kg] where, Bf Bi - final and initial biomass of the batch [kg].

Individual weight gain – was determined with the formula: (Wf - Wi) / N [g / ex.] Where, Wf, Wi - final and initial average mass of the lot [g], N - number of specimens [ex].

Daily growth rate - (DGR) - was determined applying the formula:

(Wf - Wi) / T [g / day] where, Wf, Wi - average final and initial mass of the batch [g];

T - duration of the growth cycle [days].

Survival rate - (%) - was determined by the formula: Nf / Ni x 100 [%] where, Nf, Ni - final and initial number of species.

The Fulton condition factor was calculated as follows: K = Wx 100 / l3, where: W = fish weight, in g; l = standard length, in cm;

The food of the biological material consisted of a special feed obtained by cold microextrusion, with slow immersion, microcapsulated to protect the nutrients and to preserve the water quality, composed of fishmeal, fish oil with 60% crude protein, fat crude 15% with a grain size of 0,4 mm and 0,6 mm and extruded feed with a high content of fishmeal, with crude protein of 54%, crude fat 18% with a grain size of 1,5 mm, depending on age of biological material. The frequency of food administration was daily, in five portions at the same time. The amount of feed administered was 10% of the biomass.

The methodology applied for the study of the adaptation and growth in floating fish cages located in the CM Lunca irrigation canal focused on the following aspects:

- determination of the physico-chemical parameters of the water from the CM Lunca irrigation canal before and after the placement of the ponds to verify their compatibility with the crop species;
- storage, study and interpretation data of physico-chemical and hydrobiological parameters;
- performing and storing biometrics on batches of fishery material harvested by control fishing, once a week;
- statistical processing of technological indicators in order to determine growth parameters;

The most important water parameters in the CM Lunca canal monitored before the location of the cages in the canal and during the research were: temperature - one of the most important factors as it regulates metabolism (appetite level, respectively growth spurt); dissolved oxygen - influences appetite, health, disease resistance and growth density; water level fluctuation in the canal, turbidity, speed of water flow on the canal.

RESULTS AND DISCUSSIONS

The carp breeding system in floating cages in the CM Lunca irrigation canal is an open system (*photo no. 5* - the environment influences the growth of biological material and the cages interact with the aquatic environment).

Photo 5 The influence of the aquatic environment

The location choice of the cages on the irrigation canal took into account possible sources of pollution, neighboring agricultural activities, phytoplankton and zooplankton, bathymetry and the type of substrate, access to the area.

Based on real observations and interviews effected among sport fishermens, the fish species present in the irrigation canal were: (perch, pikeperch, crucian carp, bream, common bleak)

The choice of the species took into account the market potential, the market availability of the fingerling stage for the popular, the resistance and tolerance to high growth densities and handling.

Lastly, choice of the floating fish cages model was made taking into account the compliance with the optimal values of dissolved oxygen which is closely related to the renewal of water in the pond and the small dimensions of the cages (1,5x1x1,5m).

The physico-chemical parameters of the water, determined both before the population and during the analyzed period were within the optimal range for carp growth (fig. 1). Dissolved oxygen varied within tight limits, between 6.24 mg / l and 8.43 mg /l.

The Fulton condition factor (K) ranged from 2.1 to 2.4; the state of maintenance varies between *very good* and *exceptive*.

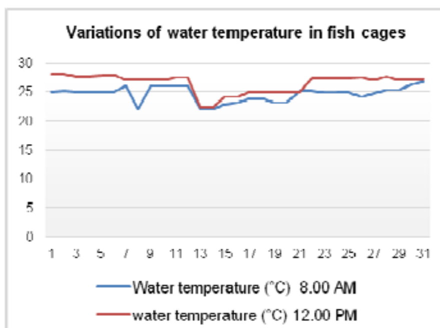

Fig. 1 Variations of water temperature in fish cages

Following the analysis of the biometric data, at the end of experimental stage 1 the average individual mass of the carp specimens varied from 9.5 g / ex. In the pond 4 to 13.2 g / ex. in pond 2 according to the following table.

Table 1 Bioproductive indicators acquired in experimental cages

Parameters	V1	V2	V3	V4
Population				
Number of carp exemplars/ cage	300	300	300	300
Cage volume [m^3]	2	2	2	2
Distance from the cage to the top of a dyke [m]	17.5	22	30.5	30.5
Initial biomass [kg]	0.09	0.09	0.09	0.09
Individual weight [g]	0.3	0.3	0.3	0.3
Initial density [ex/ m^3]	150	150	150	150
Fishing				
Number of carp exemplars/ cage	246	250	245	240
Final biomass [kg]	2.34	3.3	2.43	2.66
final individual weight [g]	9.5	13.2	9.9	11.1
Survival rate [%]	82	83	82	80
Final density [kg/m^3]	1.17	1.65	1.21	1.33
Growing parameters				
Number of days for growth	30	30	30	30
Individual weight gain [g]	0.03	0.05	0.03	0.04
Total weight gain [kg]	2.25	3.21	2.34	2.57
Total quantity of the distributed food [kg]	7	10	7	8
Daily growth rate of fish [g/zi]	0.07	0.11	0.08	0.09
Fulton condition factor [K]	2,2	2.4	2.3	2,1

The best results were obtained in the pond no. 2, located at 22 m from the top of a dyke, where the depth and speed of water flow determined the maintenance of the cage volume, faster adaptation and better food assimilation.

The difference between the minimum and maximum water level on the irrigation canal was 0.31 m (Fig. 2.)

In V2 the water level varied between 2.08 m and 1.82 m.

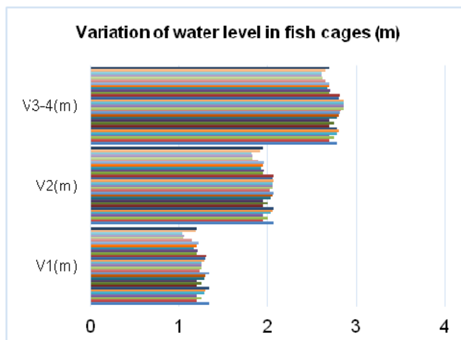

Fig. 2 Variation of water level in fish cages (m)

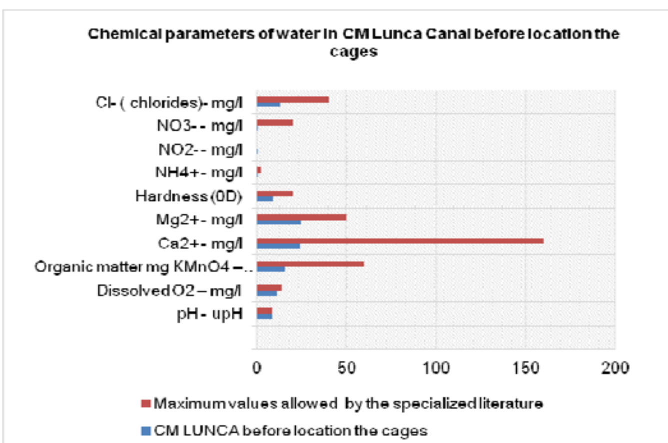

Fig. 3 Chemical parameters of water before population of carp fish

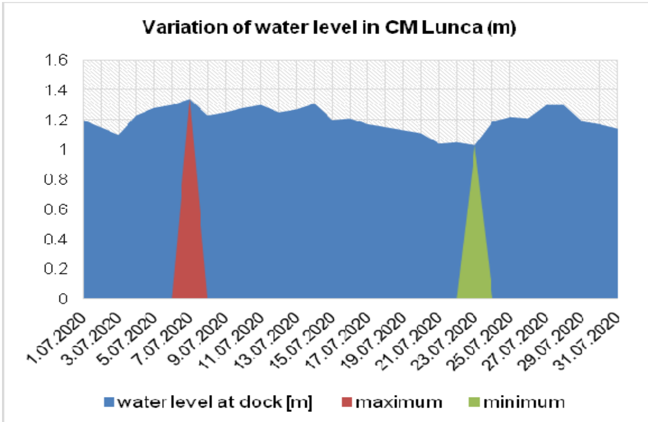

Fig. 4 Variation of water level in CM Lunca (m)

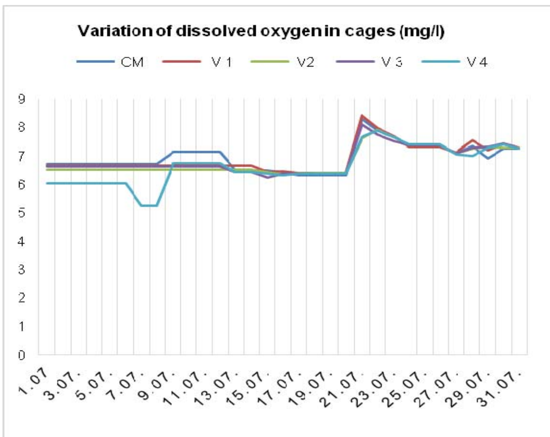

Fig. 5 Variation of dissolved oxygen in cages (mg/l)

CONCLUSIONS

- irrigation canals have the opportunity to improve volumes of water intended for agriculture and fish farming, and water that transits them is an important source of nutrients for agriculture.

- fish farming on irrigation canals can be practice in good conditions, can generate increased fish production at low cost, by excluding the costs of technological water, large investments of fish pond management. It can also contribute to higher agricultural production per hectare through irrigation water with a high content of nutrients that constitute waste and uneaten food from fish and avoids the phenomenon of water pollution or the costs associated with remediation.

- adaptation of common carp (*Cipryinus carpio*) to intensive growth in floating fish cages in CM Lunca irrigation canals was achieved quickly, in a range between 3 and 7 days, after prelimnary assessment of the site, after that monitoring of the main physical and hydrochemical parameters of the water, but also technological and ethological (the speed with which fish respond to a stimulus: human presence, swimming, food management, body position in water, etc.).

- floating fish ponds are removed in autumn at the end of the rearing period, stored over the winter and reassembled in spring at the beginning of a new growing season, with a long-term use. They are very flexible and can be considered as a mobile unit that can be assembled in any other location, depending on the opportunities.

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Links:

[1] http://www.fao.org/3/a-i4508e.pdf

[2]https://www.researchgate.net/publication/334662123_Biofouling_in_marine_aquaculture_a_review_of_recent_research_and_developments