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GENERAL ASPECTS REGARDING THE GROWTH FRESHWATER FISH IN CUBES, AN ALTERNATIVE FOR AQUACULTURE IN ROMANIA

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ABSTRACT

Due to the increased consumption of fish, as an alternative to achieving healthy population nutrition, the development of European aquaculture also shows an increasing trend. At present, freshwater culture is about 42% of total European fish production. Valuable species, from an economic point of view, can be reared in intensive systems in cages on running waters or ponds, combined with less valuable species. There are also new species that are gradually becoming increasingly important for the fish industry in Europe. Freshwater aquaculture in Romania is based on rainbow trout and carp which are still predominant species, but there is significant demand for valuable fish species [11,12,16].

INTRODUCTION

Aquaculture practiced in Romania is largely based on traditional fish farming technologies, it is not a sufficient source of freshwater carnivorous species (pike, perch, chalice) and certain species of freshwater omnivorous fish (sturgeons, sleep, tilapia). Combined pond technologies (natural reservoirs) - in fish breeding cages (artificial reservoir) is an integrated system in the semi-intensive farming system, where fish feed on granules and fish outside the cages feed on the remains of food left unused by fish in cages and natural food. We want all entrepreneurs who are considering setting up a business based on this technology to have the minimum knowledge necessary to make the right decision. The authors recommend careful study of other specialized papers in the field depending on the species of fish that are wanted to adopted, the intensity of the population of the fish, the natural conditions, etc.

MATERIAL AND METHOD

ASPECTS REGARDING THE GROWTH OF FISH IN CAGES

1. Construction of cages

Generally, a cage is made up of a rigid net with double mesh panels with a finer net on the top to prevent floating grain flushing, a lid that prevents the fish from escaping, and at the same time provides protection against predators and floats to keep the living on the surface water [13]. The materials from which the cages are made are among the most diverse.The cage frame can be made of any material that is rigid enough to be non-deformable and resistant to the corrosion effects of water. It can be wood, steel, aluminum, glass fiber, PVC, etc. Wood or wood frames of steel must be protected by means of special, water-resistant paints of the kind used for swimming pools. The mesh size shall be chosen so as to allow free passage of water but not less than 1,2 cm, taking also into account the size of the fish [19, 20, 21, 22, 23].

Smaller cages should be provided with lids that can be made of the same materials as cages or more resistant materials. However, it should be considered that they must allow for the behavior of fish to be followed by food administration and easy access to the removal of unconsumed food or dead fish.

The floaters supporting the cages can be made of very varied materials, such as floating sponges, expanded polyester, PVC pipes, etc. The cages can be anchored to the bottom of the basin or can also be fixed by docks, floating pontoons or other rigid objects that allow this.

The shapes that cages can have are extremely varied. It is generally used in circular, square or rectangular shapes, there are many opinions that the shape of the cages does not influence the production (Figure 1).

The size of the cages depends to a large extent on that of the aquatic basin and the presence of additional aeration systems. In practice, cages with variable volumes, from 1 m3 to over 30 m3, are used, but the smallest are easier to exploit and more economical. Large cages, although having a lower cost per unit volume, yields per m3 are lower primarily due to a reduced water exchange rate between their interior and exterior. The most commonly used cylindrical cages of 1.2 x 1.2 m (diameter x depth), cubic sides of 1.2 m or parallelepiped of 2.4 x 2.4 x 1.2 m (length x width x depth), 2,4 x 1,2 x 1,2 m and 3,7 x 1,8 x 1,2 m. These sizes are recommended by fish breeders experienced in raising fish in cages.

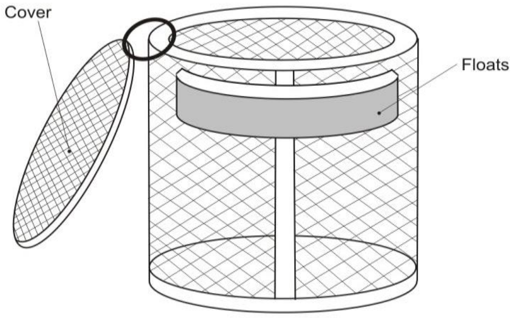

Figure 1. Cage lifting cylinders (Masser)

Figure 2. Cages for fish growth

There are also much bigger cages, they are generally used in the marine environment but also in the case of large surface lakes. In Romania, modular living systems (Figure 2) have been built together with access ways (some pontoons wood). The cage are circular, with a 6 m side and a 4.5 m deep, with a volume of approx. 420 mc. In these cages you can grow all fish species that are suitable for this technology [18].

2. Location of cages

Many types of aquatic basins can be used successfully for practicing this method of fish growth, including ponds, natural or artificial lakes, various accumulations of water, canals or even flowing water courses. For aquatic basins to be appropriate, they must meet the following conditions [22, 23]:

- their surface is better than half a hectare.
- the shores should not be easily erodable and the access of animals to them should be restricted or even prohibited.
- aquatic ponds shall be at least 2 meters deep on more than half of their surface, and especially in the area where the cages is located. This ensures that there is a space of at least 0.5 m under cages, enough for fish faces and unconsumed

forages not to accumulate, but to fall on the bottom of the basins.

Also, at a depth of more than 2 m, the submerged macro flora is poorly developed, so it does not impede the good circulation of water through the walls of the cages as it would happen at lower depths.

- the water level should not fluctuate more than 50-60 cm during the summer
- there must be a way to access the basin that is practicable under any environmental conditions. This is another essential condition for fish to grow in cages, as this method requires daily feeding and monitoring of fish. Also, when additional aeration is used, access to an electrical source is required.
- aquatic basins should not show too many fish outside the cages as they affect the production inside the cages.

3. Feeding the fish grown in cage

Irrespective of the species that grows in this system, feed to fish has a decisive influence on production results. Since fish in cages cannot benefit from natural food, only nutritionally balanced nutritionally granulated feed can ensure good growth but also a good state of their health.

The feed must not be sink, but remain on the surface of the water or fall very slowly, so that the fish have enough time to consume it before it passes through the meshes of the bottom nets. Feed is administered in at least two secrets per day at regular intervals for at least 6 days a week [3, 4, 14].

The amount of food to be administered varies depending on age fish, temperature [6, 15, 17], water quality, health, etc. being generally between 1-5% of an individual's body weight. Currently, two types of food dispensers: reflex dispensers and automatic dispensers.

The dispensers on request fig. 3 are made up of a hopper for storage of the feed axially passed through a vertical rod immersed with the bottom in the culture water which, when touched by the fish, causes the granules to fall into the water.

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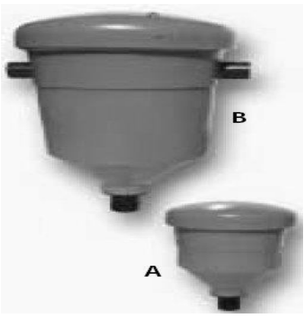

Fig. 3. Distributor on request

Fig. 4. Vibrator automatic distributor

Automatic dispensers are periodically activated with timer relays that are programmed to operate at certain intervals the time required for the technological feeds required. The automatic dispensers (Figures 4, 5, 6, 7 and 8) can be: vibratory, helical screw, pallet dispenser, rotary disk, etc.

Fig. 5. Spiral screw distributor

Fig. 6. Pallet dispenser distributor

Fig. 7. Rotary disc distributor

Fig. 8. Vibratory dispenser dispenser

4. Ventilation of fish growth systems in cages

4.1. Characteristics of dissolved gases

The gas - to - water level can be expressed as concentration (C - mg / l), voltage (T - mmHg) or as a percentage of its saturation concentration in water [6,9].

The correlation between the concentration of a water dissolved in water and its tension, according to Henrz's law, is:

$$Ti = Fi \times Ci$$

where:

- Fi = factor of conversion of the dissolved gas tension (mmHg / mg / l); Fi parameter values depend on water temperature (Table 1).
- Ti = dissolved gas tension (mmHg);
- Ci = concentration of dissolved gas (mg / l),
- i = the dissolved gas species

By summing the partial pressure, Ti, of all the gases present in the solution results in the total dissolved gas tension (TGP), namely:TGP = Σ TiThe difference (ΔP) between total dissolved gas tension (TGP) and local barometric pressure (BP) is the most suggestive indicator of the degree of overloading of dissolved water in water.Water is considered to be over-saturated when ΔP> 0, where ΔP is defined as:

$$\Delta P = TGP - BP$$

Table 1

Vaporization pressure and solubility parameters of dissolved oxygen depending on the water temperature for freshwater (Colt)

t ºC	γ kN/m^3	VP mmHg	Dissolved oxygen		
			B	B·K·1000	F
6	9,806	7,01	0,04196	59,962	12,675
8	9,805	8,05	0,03998	57,133	13,304
10	9,804	9,21	0,03816	54,532	13,938
12	9,802	10,52	0,03649	52,145	14,576
14	9,799	11,99	0,03495	49,945	15,215
16	9,796	13,64	0,03354	47,930	15,855
18	9,793	15,48	0,03224	46,072	16,494
20	9,789	17,54	0,03105	44,371	17,130
22	9,785	19,83	0,02990	42,785	17,762
24	9,780	22,39	0,02892	41,328	18,388
26	9,775	25,22	0,02798	39,984	19,007
28	9,770	28,36	0,02711	38,741	19,618
30	9,764	31,80	0,02630	37,583	20,218

The meaning of the notations in the table is as follows:

t = water temperature (ºC)

γ = specific water weight (kN / m^3);

VP = water vapor pressure (mmHg);

B = Bunsen coefficient (gas / pressure at 760 mm Hg pressure absolute);

K = ratio of molecular weight to volume of gas (mg / ml);

B · K · 1000 = gas solubility (mg / l at a partial pressure of 760 mm Hg);

F = conversion factor of dissolved gas tension (mmHg / mg / l).

The degree of saturation can also be estimated as follows:

$$\% \text{ saturation} = \frac{TGP}{BP} \cdot 100$$

Dissolved gases in water are mainly oxygen, carbon dioxide and nitrogen.

The critical concentrations of dissolved carbon dioxide (DC), presented in Table 2 may affect renal activity by stimulating the precipitation of phosphate anion in calcium phosphate and depositing it into the renal channels. A high DC concentration can also reduce the blood's ability to carry oxygen.

Table 2

Criteria for estimating the dissolved gas concentration in the case of intensive fish growth conditions (Colt)

Caracteristics		**Growth conditions**	
		Cold water (12ºC)	**Hot water (25ºC)**
Dissolved oxygen (DO) (reduced)		5-6 mg/l	3-4 mg/l
Dissolved oxygen (DO) (high)		21 mg/l	16 mg/l
Dissolved oxygen tension (high)		300 mm Hg	300 mm Hg
Dissolved carbon dioxid (DC) (high)		20 mg/l	20 mg/l
Difference pressure (ΔP) (high, all stages)		10 mm Hg	20 mm Hg
ΔP (high, specific for different stages of development)	Icre	45 mm Hg	**
	Larve	35 mm Hg	20 mm Hg
	Juvenili	10 mm Hg	50 mm Hg
	Puiet	<30 mm Hg	**

The efficiency of aeration / oxygenation equipment is conditioned by the judicious design of the tower according to the following factors: the technologically required oxygen addition rate: the allowable limits for nitrogen content dissolved (DN) and carbon dioxide (DC); admissible degree of over-saturation (ΔP); the predictable changes of the DO, DN and DC variables for a certain type of contactor.

4.2 Performance indicators of air - oxidization systems

- In the practice of aquaculture farming systems, a variety of equipment is used to enrich the water content of oxygen, depending on the degree of production intensity and the ecotechnological particularities of the fish species. Depending on this, there are, in principle, two systems of equipment to ensure the optimum oxygen content of water, namely: air-to-air aeration equipment and pure oxygen input equipment in the water mass; each of these systems is characterized by specific performance indices.

Ventilation growth systems generally use air-to-air aeration equipment (water / air contactors). The main aeration equipment used in these are: floating surface stirrers, submersible air diffusers, surface ejector with ejector tube, water jet agitators, etc.

Air-to-air aeration systems are designed to accelerate the absorption of oxygen in the air by various processes most commonly used to consist primarily in increasing the water-air contact surface and / or introducing air under pressure into the mass of water.

The standard rate of oxygen transfer (SOTR) is the product of the mass transfer coefficient, the saturation concentration of the dissolved gas and the volume of the contactor fluid, according to the relationship.

$$SOTR = (KLa)\ 20ºC \cdot (C\ ^*)\ 20ºC \cdot V \cdot 10^{-3}$$

where:

- SOTR = standard oxygen transfer rate (kg / h);

- (KLa) 20ºC = global mass transfer coefficient at the standard temperature of 20 ° C (1 / h);
- (C *) 20 ° C = saturation concentration of the dissolved gas (mg / l);
- V = volume of liquid in the contactor (l).

Standard Aeration Efficiency (ESA) is an indicator that expresses the energy efficiency of aeration equipment; the physical significance of the SAE indicator is the ratio between the standard rate of oxygen transfer for a particular type of equipment and the power consumed by it, according to the relationship:

$$\text{SAE} = \frac{SOTR}{PW}$$

where:
- SAE = standard aeration efficiency (kg / kW · h)
- PW = the power consumed by the aeration equipment (kW);

SOTR = (KLa) 20ºC · (C *) 20ºC · V · 10-3

where:
- SOTR = standard oxygen transfer rate (kg / h);
- (KLa) 20ºC = global mass transfer coefficient at the standard temperature of 20 ° C (1 / h);
- (C *) 20 ° C = saturation concentration of the dissolved gas (mg / l);
- V = volume of liquid in the contactor (l).

In the case of non-standard temperatures, it is necessary to correct the values of the SOTR and ESAs by considering the following parameters: actual (actual) values of dewatering concentrations, barometric pressures and water composition (surfactant content and suspended solids).

The performance of diffusion aeration equipment is expressed by a specific indicator, namely the oxygenation efficiency (OE%), which is determined with the relation:

$$\text{OE} = \frac{OTR}{Q_{aer} \cdot P_{aer} \cdot X_{O_2}} \cdot 100$$

where:
- OTR = oxygen transfer rate (rate) (kg / h);
- Qaer = volumetric flow rate of the air introduced into the water (m^3 / h);
- P_{aer} = densitatea aerului introdus (kg/m^3);
- X_{o2} = fracţia molară a oxigenului.

4.3 Surface aeratours

Surface aerators provide, by various methods, spraying air in water or spraying water into atmospheric air in order to achieve the largest contact surface at which gas will be exchanged between the two phases [5]. The main constructive variants of surface aerators used in aquaculture farming systems are: floating surface agitators, surface ejectors with ejector tube and water jet aerators. Below are some models of aerators:

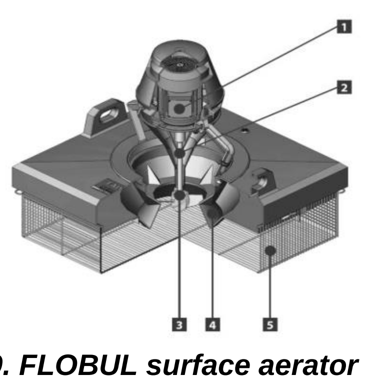

Fig. 9. FLOBUL surface aerator design

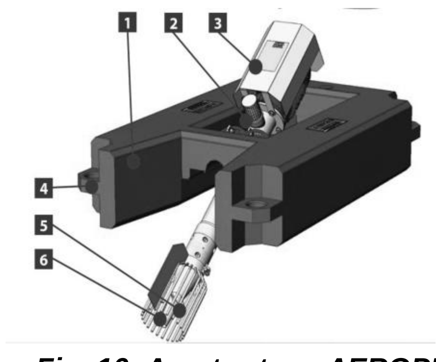

Fig. 10. Aerator type AEROPULSE

The FLOBUL fan (Fig. 9), manufactured in France, consists of an electric motor at a speed of 1,500 rpm, (1) which has a four-blade propeller (3) mounted directly on the shaft.

Propeller driven water is sprayed into the atmosphere by a conical diffuser nozzle, (2). The aerator is supported on the water surface by floats made of high-density polyethylene (4), and a stainless-steel sieve (5) is provided at the bottom for protection against the penetration of impurities and fish. The AEROPULSE aerator (fig. 10) consists of an electric motor with a speed of 3,000 rpm, (3), which has a 3-blade propeller (5) mounted directly on the shaft. The position of the propeller motor can be adjusted as necessary between 30° and 90° to the surface of the water gloss by means of a special device (2). The aerator is supported on the surface of water by floats made of high-density polyethylene (1 and 4), and is provided at the bottom with a stainless-steel sieve (6). Aspiration air from the atmosphere is introduced into the water which in turn is strongly agitated by the propeller thus creating the premises of a very good air-water mixture.

5. Monitoring and control of water quality

The main objectives of the monitoring and control of aeration equipment are to minimize energy consumption and ensure a long service life [6,15,17].

Measurement of oxygen concentration in water as well as other physico - chemical water can be carried out continuously or at intervals. Measurements made at time intervals are done with handheld probes (Fig. 11, 12).

Fig.11. Oxygen measurement device

Fig.12. PH meter

RESULTS AND DISCUSSIONS

Aquaculture in general can generate great material satisfaction if entrepreneurs in this field are armed with specialized solid knowledge [18]. In cases where specialists recommendations are not followed, the problems that may arise in aquaculture practiced in the wild are as follows:

a) damages arising from chemical agents

Water, as a fish's living environment, is defined as a suspension of more or less numerous chemicals that give it a whole set of properties [9,10].

Maintaining these properties within certain limits, against which the fish have adapted during their phylogenesis, is a normal chemistry, favorable to the growth and reproduction of these fish.

Abnormal fish chemistry can be determined by:

- unwanted processes naturally produced in ponds;
- deliberate or forced waste spills from agriculture, animal husbandry, industry, community activities, etc.;
- mistakes in the application of pool maintenance technologies;
- mistakes in the application of breeding and fish breeding technologies;
- drug substances used for different treatments;
- fish distributed to fish, inappropriate qualitatively and quantitatively.

Although the accumulated knowledge of the pathophysiological effects of the chemical properties of water and their zootechnical consequences are numerous, they remain far from satisfactory.

b) water temperature as patogen factor

For fish - animal poikiloterme, water temperature is one of the main factors of living. Each species, however, falls within certain limits and according to them they are grouped on certain sectors of the running waters or at a certain depth in lakes or seas. If weather conditions or human intervention are exceeded limits over a longer time, whether above or below the lower limit, the fish suffer due to metabolic deficiencies. Particularly high and sudden temperature variations trigger high mortality [6, 15, 17]. Table 3 contain the pathophysiological incidences of temperature variations on both sides of the optimum area.

Table 3

Pathophysiological Incidences of temperature variations on both sides of the optimum area

Effects pathophysiological	Suboptimal temperatures	Overoptimal temperatures
Metabolism bazal	reduced	high
Metabolic activity	reduced	diminuată
Oxygen consumption	reduced	high
Respiratory rhythm	reduced	high
Gill absorption and penetration of the toxin	reduceds	highs
Defense reactions	reduced	high
Gastrointestinal motility	reduced	high
Pathological risks	bio aggressors	medial compounds and bacteria

The indirect effect of water temperature on the health status of fish is felt by:
- conditioning the values of the qualitative parameters of the water to which the fish is very sensitive, such as the oxygen;
- Stimulating the proliferation of algae, some of which are toxic and bacteria with a role in the mineralization of organic substances in decomposition;
- stimulating the multiplication of bioaggregators.

c) materials in suspension

Suspended matter are solid, finely divided solids of a mineral or organic nature present in water, which gives it a turbid state.

The indirect effect of suspended matter is more complex and consists of:
- diminishing brightness;
- reduction of photosynthesis;
- increased water temperature as a result of increased caloric absorption;
- retaining a smaller amount of oxygen in water;
- diminishing primary production and natural production. Suspended materials come from precipitation, from various pollutant sources.In intensive fish farming, manure is a source of suspended matter. Optimal values of the amount of suspension material recommended in aquaculture are:- for eggs incubation, in salmon culture, <25 mg/l;- in other cases, <75 mg/l.

d) gas overseas

Atmospheric gas over-precipitation is the cause of skin emphysema (gas bubbles under the skin) or gaseous emboli of 110 - 115%. As saturation increases, the exposure duration required for triggering morbid disorders decrease. The passage of air from the gaseous to the solvated state in the fish body generates these disorders.

Causes of water over-precipitation in solvates can be both natural and induced.

e) insufficient content of oxygen in water

Insufficient oxygen content in the water leads to fish asphyxia or decreased performance (slowing down, poor food assimilation, aggressive sensitivity) [5]. Poor oxygenation of water is also a stress factor for fish. The most common factor responsible for lowering the oxygen content of water is the pollution with organic substances from waste water (from agriculture, food industry, sewage, fodder, excrement).

Fish can often die by choking in winter, in densely populated basins, as well as in summer in polluted waters with high temperature and weak current.

Deficiency in solvated oxygen in the water causes the fish to suffocate and ultimately to die; the different species die successively, depending on the amount of oxygen they need. Oxygen-depleted fish are no longer fed, swim near the surface of the water, they breathe mildly, clump to the feeding holes, are apathetic, devoid of reactivity, lose orientation reflex and die.

The damage caused to fish by the presence of a large amount of oxygen in the water is rare. These can occur, for example, when the fish is transported in polyethylene bags with atmospheric oxygen. Excess oxygen in water can lead to fish paralysis.

f) excess of carbon dioxide in water

Carbon dioxide is solubilized in water in molecular state; only 10% of it forms carbonic acid.

In stagnant waters, the CO2 level is stratified due to photosynthetic assimilation of the phytoplankton, respectively the layer above has less CO2 free than the lower layer. It is possible that in the surface layer, free carbon dioxide is consumed entirely in the photosynthesis process, in which case the pH of the water can rise to more than 8.3.

g) pathological state caused by water from nitrogen substances

Nitrogen compounds in fish pathogenic water are ammonia (NH3), nitrites (NO2-) and some cases of nitrates (NO3-).

They result from the decomposition of dead organic matter, from the reduction of nitrates and nitrites present or organic, or, be produced by metabolism, such as ammonia.

Among the pathological conditions of fish caused by nitrate, the most common are ammonia and nitrite poisoning.

CONCLUSIONS

- the high density of fish in the cages can cause problems with water quality and the spread of disease;
- fodder must be unaltered and nutritionally complete, providing all the protein, carbohydrates, lipids, vitamins and minerals needed;
- cages can be easily vandalized, which requires strict guarding of them;
- daily intervention is required at each cage level.
- if no additional aeration is applied, the production per hectare may be less than in the semi - intensive growing system in the pond;
- all of the above can be considered disadvantages, but they can enumeration and many advantages that could be safe arguments for many fish farmers to apply this method of fish growth on their own farm. Among these, the following can be mentioned:
- the method can be practiced on water courses or aquatic basins of the most varied (ponds, reservoirs or natural lakes etc.) that are not suitable for emptying or emptying;
- the costs of building / arranging the ponds are eliminated;
- fish growth varieties are cheap, so a relatively small initial investment is needed;
- the dynamics of fish growth is very easy monitoring;
- all the links of the technological flow can be under permanent control;
- fishing is easy, the method allows the use of an aquatic pool for both fish growth and sport fishing.

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