STUDIES AND RESEARCH CONCERNING THE CONDITIONING OF WATER CHEMICAL PARAMETERS FROM A RECIRCULATING AQUACULTURE SYSTEM BY INTEGRATING AN INNOVATIVE WATER DENITRIFYING TECHNOLOGY

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ABSTRACT

The paper aims to study the main issues regarding the productivity and efficiency of fish breeding and plant cultivation in aquaponic systems. Aquaponics is defined as a combination of aquaculture and hydroponic systems, in which waste water rich in nutrients from aquaculture system is introduced in a hydroponic system. Plants absorb nutrients from waste water thus improving and purifying water from the aquaculture system, this method providing an ecological and sustainable system. Aquaponics integrates a hydroponic subsystem and an aquaculture subsystem, constituting the optimal practice for obtaining superior yields both quantitatively and qualitatively through the use of effluents from fish as a natural fertilizer for plants, the plants giving the fish filtered and reconditioned water. Aquaponics is a symbiosis of: aquaculture (fish breeding in closed systems) and hydroponics (growing plants in water without using soil). Vegetables, lettuce, special herbs (spinach, chives, basil and watercress) have low to medium nutrient needs and are well adapted to aquaponic systems. Plants absorb nutrients from residual water and thus improve or purify water in the aquaculture system, this method provides an ecological and sustainable system.

INTRODUCTION

Aquaponics is an intensive production system where several cultures are produced with reduced inputs of water and fertilizași and it is very suitable for small agricultural producers targeting local markets and agritourism opportunities (Blidariu F., 2013; Cristea F., Radulov I., Lată F.,2011; Francis-Floyd, R., C. Watson, D. Petty D. Pouder, 2012; Hughey T.W. 2005; Martan E. 2008; NUCLEUS Program, 2016).

Aquaponic systems are more complex than the systems designed only for growing plants or fish breeding, because optimum conditions for each group of active organisms participanting in the production process - plants, fish and nitrifying bacteria, are not identical (Blidariu F., 2013; Francis-Floyd, R., C. Watson, D. Petty D. Pouder, 2012; Hughey T.W. 2005; Martan E. 2008; NUCLEUS Program, 2016).

For practicing efficient aquaponics increased attention is necessary regarding consumer demands, food security and economic efficiency, through continuous development of new technologies (Blidariu F., 2013; Cristea F., Radulov I., Lato F., 2011; Francis-Floyd, R., C. Watson, D. Petty D. Pouder, 2012**;** Hughey T.W. 2005; Martan E. 2008; NUCLEUS Program, 2016).

The fact that nutrients in the water are consumed by vegetable "layers" makes the water become usable again for fish, so it is pumped or directed by free flowing back to the fish basin and the recirculation process continues (Blidariu F., 2013; Cristea F., Radulov I., Lato F.,2011; Hughey T.W. 2005; Şumălan R.2009; NUCLEUS Program, 2016).

The waste water from fish basins, is directed through pipes, irrigates the plants placed above another basin, with their roots in the water, on a bed of gravel (or other materials), then returns to the fish basin in a continuous flow. In hydroponic cultures, plants are seeded either on floating artificial substrates or in sterile, porous, high water permeability substrate (Blidariu F., 2013; Cristea F., Radulov I., Lato F.,2011; Hughey T.W. 2005; NUCLEUS Program, 2016). This way plants receive nutrients and fish water is naturally filtered. Fish effluents contain nitrates and bacteria that favor vegetables natural and organic growth (Blidariu F., 2013; Cristea F., Radulov I., Lato F., 2011; Şumălan R. 2009; NUCLEUS Program, 2016).

In fish tanks, ammonia exists in two forms, which together are called total ammoniacal nitrogen. The nitrification proces is the two-step biological oxidation of ammonia to nitrate. The process is carried out by autotrophic bacteria that use ammonia and nitrites as a growth substrate to generate energy for the cellular activity and reproduction (Blidariu F., 2013; Cristea F., Radulov I., Lato F., 2011; Francis-Floyd, R., C. Watson, D. Petty D. Pouder, 2012; Şumălan R. 2009; NUCLEUS Program, 2016).

The efficiency of the nitrification process depends on the oxygen concentration, temperature, biomass retention time, alkalinity and pH. Nitrifying bacteria are strictly aerobic, they can nitrify only in the presence of dissolved oxygen (DO) (Blidariu F., 2013; Francis-Floyd, R., C. Watson, D. Petty D. Pouder, 2012; NUCLEUS Program, 2016).

Biological denitrification process is the conversion of nitrates to gaseous nitrogen in the absence of oxygen. This process is carried out by a part of heterotrophic bacteria, called denitrifying heterotrophic bacteria, having the ability to use nitrates and nitrites as electron acceptor in organic matter oxidation process (Blidariu F., 2013; Hughey T.W. 2005; NUCLEUS Program, 2016). The efficiency of the denitrification process is affected by the absence of dissolved oxygen, the presence of a suitable and active population of denitrifying bacteria, pH, temperature, nutrients and redox potential (Francis-Floyd, R., C. Watson, D. Petty and D. Pouder. 2012; Martan E. 2008; Şumălan R. 2009).

MATERIAL AND METHOD

The hydroponic subsystem have the following main components:

- Two hydroponic tanks, (Fig.1) placed on two metal supports. The water coming from aqaculture subsystem, supplies, in parallel, each of the two tanks, being introduced at one of their ends and then removed at the opposite end;
- Floating supports for plants, made of expanded polystyrene, presenting holes where the lettuce seedlings are planted;
- Devices for regulating water level in hydroponic tanks;
- Taps for regulating water flow rate in hydroponic tanks;
- Plant lighting panels, placed over the hydroponic tanks, so that the distance to plants be adjustable, have the role to ensure the light necessary for photosynthesis (NUCLEUS Program 2016).

Figure.1 - Hydroponic tanks

Figure 2 - Lighting panels placed above the hydroponic tank

Lighting panels will be placed above the hydroponic tank so that the distance can be adjustable and are intended to provide light necessary to photosynthesis, thereby ensuring a good development of the plants (Fig.2) (NUCLEUS Program 2016) .

Connecting the hydroponic system to the aquaponic one is made using fittings and fixtures so that water supply for hydroponic basins can be ensured either through the outlet pipe or the supply pipe of the biological filter. Water removal from hydroponic basins will be made through the supply pipe of the mechanical filter (NUCLEUS Program 2016).

Determining water quality, in different phases of the technological process, will be made by taking periodical samples and their analysis in laboratory.

The denitrifying installation from aquaponic cultures that will be used during the experiment has the following main characteristics (NUCLEUS Program 2016):

- Type of culture ....aquaponic
- Fish species bred in recirculating acvacole systems ....sturgeons
- Hydroponic culture vegetables ....lettuce
- Hydroponic culture surface……....... ………………………………...8 m^2
- Culture density (lettuce) …………………………………………..14 piece/m^2
- Average water need for lettuce growing ....1,5 m^3/day
- Lighting type ……………........…..LED lamps
- Energy source ……………..……………………………………..photovoltaic panels.

RESULTS AND DISCUSSIONS

The constructive features of the denitrifying installation are listed in the table below:

Table 1

Constructive features of the denitrifying installation

No. crt.	Characteristic	M.U.	Measured Value
1.	Length of the aquaponic tank	mm	4000
2.	Width of the aquaponic tank	mm	1000
3.	Height of the aquaponic tank	mm	340
4.	Water supply nozzle	ϕmm	25
5.	Water outlet nozzle	ϕmm	32
6.	Length of the floating support	mm	970
7.	Width of the floating support	mm	500
8.	Height of the floating support	mm	20

The hydroponic subsystem (Fig.3) works as follows: plant growth water is taken from the main supply pipe of the fish-growing tank through a connecting collar and distributed to the two plant growth pools. The two branches of the distribution network are provided with a separating valve and a water flow control valve. The water supply pipe is placed along the plant growth basin in the vicinity of a side wall.

The water reaches the basin through the five equidistant slits in the duct. At the end of the feed pipes of plant breeding tanks, taps are used to collect water samples for analysis. The water is drained by gravity flow through the five orifices made on the bottom of the basin, placed transversely opposite the feed duct, adjacent to the feed slots. Before reaching the exhaust pipe from the subsystem, the discharged water passes through the regulating device and maintains a constant level in the tank. The lighting installation panels are placed above the hydroponic basins so that the distance from the plants is adjustable and is intended to provide the light necessary for photosynthesis, thus ensuring a good plant growth**.**

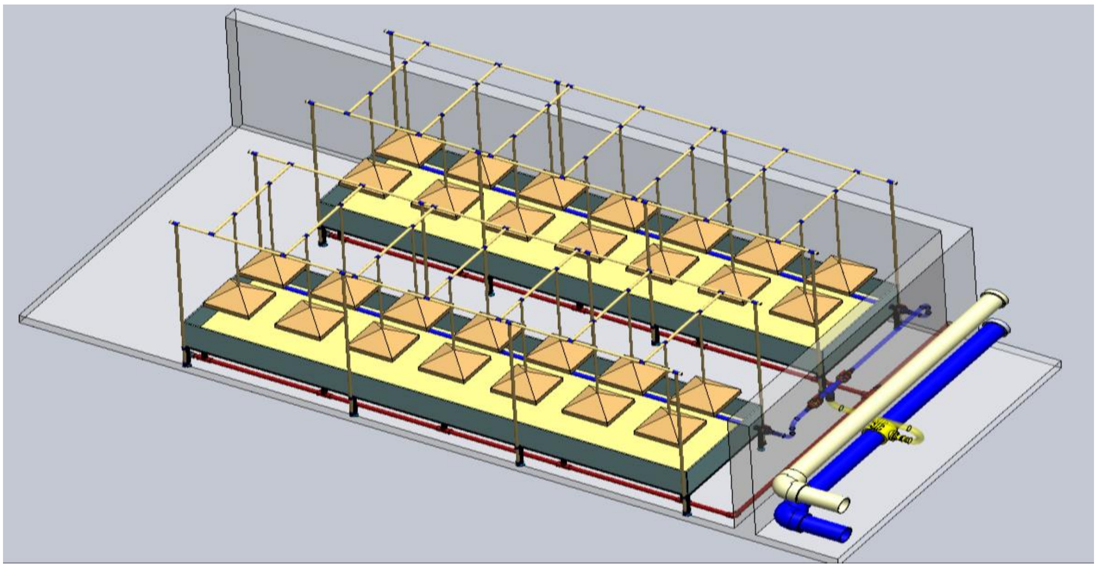

Figure 3 - 3D project of the denitrification installation in hydroponic cultures

The water flow rate depended on the dissolved oxygen content and the temperature of the water. Determining the water quality parameters were performed using the portable water analysis system. It has a series of sensors that have allowed pH, conductivity, turbidity, dissolved oxygen, temperature and salinity to be determined.

For the determination of chemical parameters of the water will compare the results of the chemical analyzes of the samples taken from the water at the inlet and outlet of the water denitrification system.

Water samples subjected to chemical analyzes were taken from the tanks feed pipe. In order to eliminate reading errors before chemical testing, they were filtered with filter paper to retain any solids.

The water quality parameters determination was performed using the Horiba CHECKER U-10 portable analytical system, produced by Horiba. It has a series of sensors that allowed pH, conductivity, turbidity, dissolved oxygen, temperature and salinity to be determined.

For the water filtration in the aquaponic module, were introduced green lettuce seedlings (Latuca Sativa). Daily water consumption and water temperature was measured, the average daily water quantity and average daily temperature was made. The illumination period was 12 hours a day.

The experimental data of the water quality of the denitrification system are presented in the table below.

Table 2

Evolution of chemical parameters of water

Experiment No.	Evolution of the pH of water	Dissolved oxygen mg/l	Temperature °C	Salinity **%**	Nitrites mg/l
1	7,94	8,64	13,4	0,01	0,05
2	7,96	8,76	13,6	0,01	0,05
3	7,85	8,95	13,1	0,01	0,04
4	7,83	8,93	13,9	0,02	0,04

5	7,64	8,98	14,3	0,02	0,02
6	7,73	9,07	14,6	0,02	0,02
7	7,75	9,12	14,9	0,01	0,02
8	7,72	9,35	14,6	0,01	0,01
9	7,58	9,35	14,8	0,01	0,01
10	7,65	9,21	15,3	0,01	Absent

CONCLUSIONS

Concerning the results obtained from chemical analyzes on in water elements , it was found there was a decrease in pH, an increase in dissolved oxygen, salinity stagnated and the percentage of nitrites was decreasing every day of the experiment and at the last experiment, the nitrites were absent.

Modern aquaponics, a branch still at the beginning, which combines aquaculture with hydroponics, judiciously applied, can sum up the benefits, and even more, can mutually neutralize some major problems of the two, such as the use as nutrients, by plants of noxious products that fish generated.

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