RESEARCH ON THE CONSTRUCTION OF STRUCTURES MICROFERM TYPE ACVAPONICS

CERCETĂRI PRIVIND REALIZAREA STRUCTURILOR ACVAPONICE TIP MICROFERMĂ

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***Abstract**. The paper must carry out studies and research on the realization of aquaponic structures under climatic conditions existing in the area of Moldova. The research is focused on designing hydrotechnical care systems to include information: water capture, decanting and disinfection line, water supply line for the planter, wastewater discharge line, air circuit line, filter installation, water treatment plant and disinfection. The hydraulic system deserves the DWC fish and fish basins. The hydrotechnical system deserves to realize an aquaponic structure located in a solarium with an area of 100 m^2.*
Key words: hydraulic system, culture system, fish pools, culture beds

***Rezumat.** Lucrarea prezintă studiile şi cercetările privind realizarea structurilor acvaponice în condițiile climatice existente în zona Moldovei. Cercetarea s-a axat pe conceperea unui sistem hidrotehnic care să cuprindă următoarele componente: captarea apei, linia de alimentare decantată şi dezinfectată, linia de alimentare cu apă a plantelor, linia de evacuare a apei uzate, linia circuitului de aer, instalația de filtrare, instalația de dezinfecție. Sistemul hidraulic deserveşte bazinele cu peşti şi bazine cu pat de cultură DWC. Sistemul hidrotehnic deserveşte structura acvaponică amplasată într-un solar cu suprafața de 100 m^2.*
Cuvinte cheie: sistem hidraulic, sistem de cultură, bazine de peşti, paturi de cultură

INTRODUCTION

In the next period of time, the human society has to solve two major problems: the water problem and the food problem. The sources of drinking water are constantly decreasing and the phenomenon of pollution is constantly increasing. Finding viable sources of drinking water in Romania has become particularly difficult. Surface water sources are highly polluted. Groundwater sources are becoming more and more polluted. Such a situation is also present in the Moldovan area.

Aquaponics is a biological system for growing plants and fish in a hydraulic system with water recirculation. The two biological components of the system ensure to each other the ideal habitat, with the mutual depollution of the water and the assurance of optimal living conditions (Bernstein, 2011).

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Small volume aquaponics (water volume below 3000 L) are suitable for a family or microfarm (Somerville *et al.,* 2014). A wide range of plants and any species of fish can be introduced into the aquaponic system. In this case, vegetables (spinach, salad, bacon, parsley, etc.) and fruits (strawberries) are suitable. For a number of crops (eg peppers and tomatoes) potassium, calcium and iron should be added. Fish suitable for aquaponics in Romania are carp, rainbow trout. Under the Romanian conditions the Tilapia species can be used. In Romania, aquaponics systems are in the early stages and there is virtually no aquaponics unit on a commercial scale. Most are of small volume and are used as a basis for experimental research.

The purpose of the paper is to present the concept of application of an aquaponic structure with DWC culture technique, small volume for a microfarm, under the climatic conditions of Moldova and for a variation of the type of plants and fish species. The first research phase is focused on designing the hydraulic water supply and drainage circuit.

MATERIAL AND METHOD

The research was carried out in the area of Moldova, respectively in the city of Tomeşti, located on the border of the city of Iasi.

The research area is characterized by the following geophysical characteristics:

- location in the relief area of the Moldavian Plain in contact with the Central Moldavian Plateau area;

- the climate is temperate - continental, in a province sector with aridity; average annual rainfall is 500 - 600 mm; the average annual temperature is 10 ^{0}C: the average annual thermal amplitude is high, with the value 24-26 0C.

- the solar radiation is excessive during the summer and is greatly reduced during the winter; light intensity has a summer value of 30,000 - 100,000 luces in summer, and in winter of 4,000 - 10,000 luces; vegetable plants have a good assimilation to an intensity of 20,000 - 30,000 luces.

For the research, a closed space such as a solarium was used. It was arranged according to the research topic.

Theoretical and experimental research was carried out on the following fields:

1. Design and realization of a hydrotechnical water supply system of a small size aquaponics structure with DWC culture technique in the climatic conditions of the N-E area of Romania.

2. Analysis of how to adapt to the small space of a solarium the hydrotechnical water supply system and the DWC cultivation equipment.

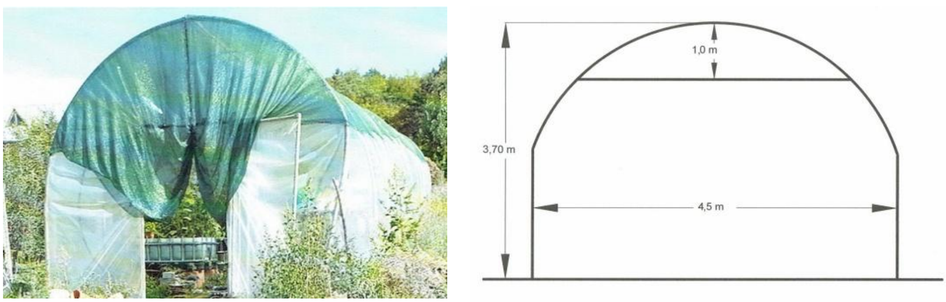
3. Research on the behaviour of small-sized aquaponics structures with DWC culture technique in differentiated exploitation processes by plant and fish species.

The research analyzed a series of technical documentation of small and medium sized aquaponics structures made internationally and nationally and especially for temperate continental areas with high aridity.

RESULTS AND DISCUSSIONS

An aquaponic system consists of two major components: the fish breeding facility and the plant culture system. Fish are raised in one or more pools, and the plants are cultivated by several processes that use the waste water from fish. The two major structural components are served by specialized auxiliary installations on the transport of clean and polluted water, on the air supply, on the discharge of waste water and waste, on the lighting and heating of the production space, on the control and monitoring of the exploitation process, etc.

The aquaponic culture system is located in a greenhouse made of a metallic structure covered with HDPE foil with a thickness of 50 microns (single greenhouse, with the shape of a semi-circle roof, high tunnel) (fig. 1). The greenhouse is located on a hill, in an area without trees (shaded area) and with the long side facing the East-West direction. The greenhouse has a length of 20 m and a width of 4.5 m, with an area of 90 m^2. The greenhouse is covered with shading net, where the degree of shading is 75% (Ursachi, 2017).



a b

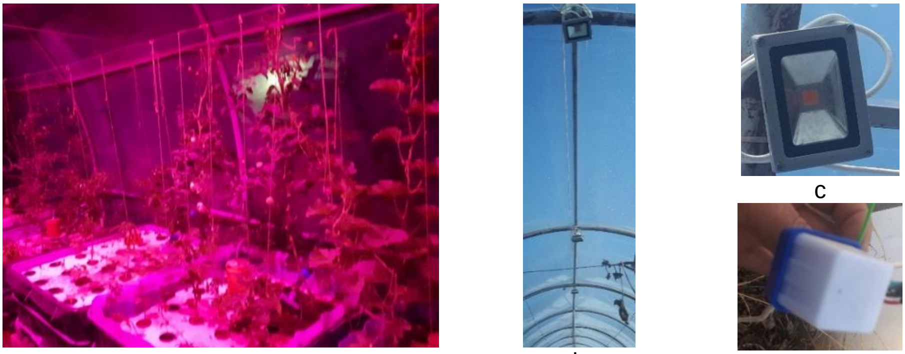
Fig. 1 Greenhouse for the placement of the aquaponic structure: a - general view of the greenhouse; b - the geometric scheme of the greenhouse (Ursachi, 2017).

The greenhouse is made without a heating system, because the operating time is temporary (only during the growing season). The aquaponic structure was moved during the cold period of the year in a heated space at a temperature of 21 - 22 ^{0}C.

The greenhouse is illuminated naturally and artificially. Artificial lighting is done with growing lamps (fig. 2.a). They operate on 3 light spectra - red, yellow, blue and strictly generate the light spectrum required for plants. Three growth lamps (figs. 2.b and 2.c) have been mounted on the greenhouse skeleton, which provides night illumination with a luminous intensity of 100 luces each. They come into automatic operation, being activated by a photocell sensor (fig. 2.d).

The purpose of the hydrotechnical system is to retrieve water from the source and transport it to the consumer (fish + plant). The layout of the hydrotechnical system is carried out in accordance with the topographic, geotechnical, hydrogeological conditions, the geometrical characteristics of the solarium, the characteristics of the aquaponic installation. The scheme of the hydrotechnical system has the following components:

- water outlet adapted to natural source (underground from the site area, public water supply network); the groundwater is taken after a well equipped with a pump; 25 minutes, Pn 6.0 bar and is metered;



a b c d

Fig. 2 Greenhouse lighting system: a - service lighting; b - lamp placement scheme; c - lamp; d - lighting trigger sensor (Ursachi, 2017).

- the drilling adduction is made of a PEHD pipe, Dn 63 mm, Pn 4.0 bar; the adduction from the public network is made of galvanized steel pipe with Dn 25 mm, Pn 6.0 bar;

- tank for the storage and heating of water when the source is underground, or for the removal of residual chlorine for water from the public network; the tank has a volume of 250 L and is made of a PVC; the tank is underground and is equipped with an extruded polystyrene thermo-system;

- supply pipe to make the connection between the storage basin and the installation serving the solarium; the pipe is made of HDPE with Dn 63 mm, Pn 4 bar; a water disinfection plant is located on the supply line;

- network of pressure pipes with the role of water transport and distribution at the elements of the aquaponic structure; the pipe network is made of PEHD pipe, Dn 32 mm, Pn 4.0 bar, provided with bypass and control valves, drain valves;

- mechanical filtration and biofiltration systems;

- waste water sewerage network made from a PVC Dn 110 manifold connected to the local sewerage system;

- devices and installations for measuring and controlling the meteorological parameters (temperature and humidity of the air), water (temperature. pH, content of substances), hydraulics (volume of water, flow, pressure).

The fish tanks (fig. 4.a) are made of white plastic, UV resistant and have a volume of 1 m^3 each. Each tank is fed through a PVC pipe Dn 32 with a flow rate of 0.15 L/s. The fish pools were equipped with juvenile Tilapia de Nile and juvenile Tilapia de Mozambique.

The plant cultivation technology is of the "deep water" type (DWC) (fig. 4.b). The technology involves the suspension of plants on a polystyrene plate (fig. 4.b), and the roots are immersed in the water coming from the fish tanks. The water flows gravitationally from fish tanks, through biofilters, to basins with culture beds. The planting scheme in the beds with beds of aquaponic culture was of the type "companion plants". This concept is found in organic gardens and is based on the idea that plants can benefit from the company of others.

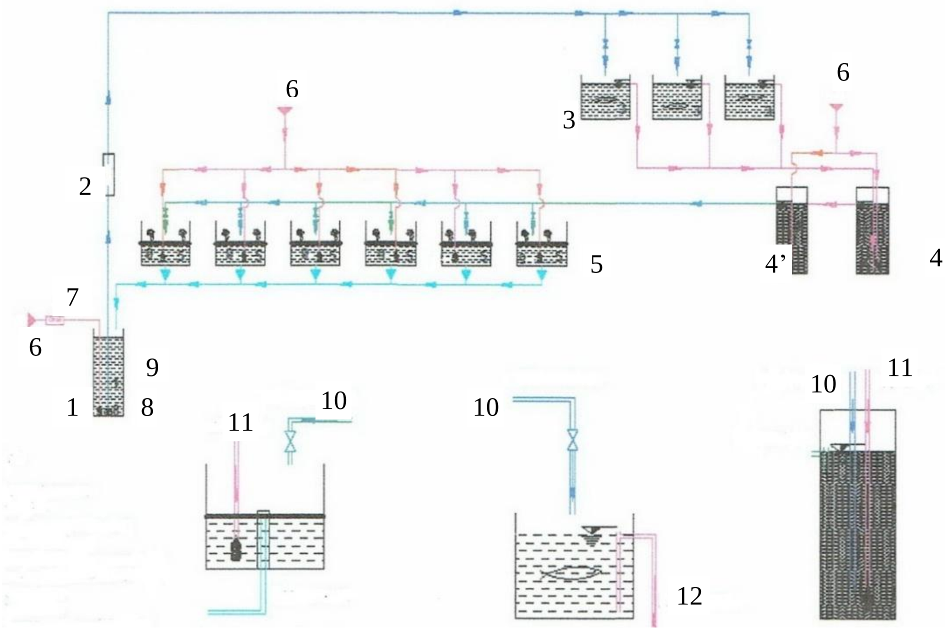


Fig. 3 The functional structure of the aquaponic system: 1 - decanter basin; 2 - UV filter; 3 - fish tanks; 4 - biological biofilter; 4 '- biological + mechanical biofilter; 5 basins with culture bed in DWC system; 6 - air pump; 7 - ozonator; 8 - submersible water supply pump in the aquaponic structure; 9 - aerator with pumice stone; 10 - food; 11 - aeration; 12 - evacuation.

a a b

Fig. 4 The solarium arrangement for the aquaponic structure: a - fish basins; b - pools with culture beds; the suspension plates of the plants (Ursachi, 2017).

The plants used in the aquaponic structure were: *Lactuca sativa* - early green salad, *Lycopersicon esculentum* - tomatoes, *Cucumis sativus* - cucumber, *Capsium annuum* - bell peppers, kapia peppers, peppers, donuts, *Ocimum* *basilicum* - basil, *Satureja hortensis* - melo - melon, *Pisum sativum* - peas, *Fragaria sp*. - strawberries, *Citrullus lanatus* - melon, *Solanum melongena* - eggplant.

The process of plant growth is achieved through the participation of nitrifying bacteria (*Nitrosomonas* and *Nitrobacer*), which convert ammonia and urea from fish manure into nitrates, which are consumed by plants.

The basins with culture beds have an area of 1.0 m^2, with a useful volume of 300 l and a water depth of 30 cm. The depth of the water allows the creation of the space for the development of the plant roots. The plant basins are fed in parallel with the flow rate of 0.09 L/s through a PVC pipe Dn 32 connected to the filtration system.

For aerating the culture beds, an air pump with a flow rate of 360 l/h was used, and the bottom of the basins is equipped with pumice stones. The air flow rate for each basin was 1.0 l/min.

The hydraulic system was designed so that after the fish tanks the water flows gravitationally to the drainage tank.

The water disinfection system entered in the hydraulic system is equipped with a UV lamp (fig. 3).

Aquaponic technology can become one of the alternative food production solutions in the future. Aquaponics is a technology that involves low costs and is extremely efficient in environmental protection. This technique can contribute to feeding the population from the disadvantaged areas. Aquaponics is a source of unpolluted food with chemicals (Ursachi and Marcoie, 2017).

CONCLUSIONS

1. Aquaponic crops can be efficiently used in the climatic conditions of Moldova by using small and medium sized systems, with applications in individual households and microfarms.

2. The research carried out under the climatic conditions in the Moldovan area indicates the feasibility of the method in feeding biological food of a microfarm served by a family, but also the existence of a surplus of products that can be used.

REFERENCES

1. **Bernstein S., 2011** - *Aquaponic gardening: a step-by-step guide to raising vegetables and fish together*. Gabriola Island, Canada, New Society Publishers.
2. **Somerville C., Cohen M., Pantanella E, Stankus A., Lovatelli A**., 2014 - *Small-scale aquaponic food production. Integrated fish and plant farming*. FAO Fisheries and Aquaculture Technical Paper No. 589, Rome, FAO.
3. **Ursachi A., 2017 -** *Studiu documentar asupra mediului în sere acvaponice şi condiționarea acestuia. Raport de cercetare 1*. Universitatea Tehnică „Gheorghe Asachi” din Iaşi, Şcoala Doctorală, Facultatea de Hidrotehnică, Geodezie şi Ingineria Mediului.
4. **Ursachi A., Marcoie N., 2018** - *Structură acvaponică cu tehnică de cultură DWC*. Revista Română de acvaponie, Anul III, nr. 1 (4), Bucureşti, pp. 6-12.