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STUDY ON BUILDING A SMALL-SCALE AQUAPONIC SYSTEM AND THE OUTSET OF IT

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Abstract
Building a small scale aquaponic system can be considered as a source of profit. On the same floor area two products could be yield: fish and plants (herbs, vegetables, salads, ornamentals). The small scale aquaponic system was built in the laboratory of Fisheries and Aquaculture of the Faculty of Animal Science of the University of Agronomic Sciences and Veterinary Medicine in Bucharest. It has two components, namely component of aquaculture and hydroponics component. The aquaculture component is represented by a tank with a volume of 450 l and the hydroponic component that is composed of a parallelepipedic box lined with PVC foil of 0.5 mm. PVC film's purpose is to retain water in the hydroponic component. The parallelopipedic box was made of OSB with reinforcements made of pine timber. The substrate chosen for plant growth was river gravel with dimensions between 8 and 16 mm. The surface obtained for the plant growth was 1 m^2. Water recirculation was done with a pump with adjustable flow of 300 to 1000 l / h. An aerator with two diffusers was used to assure the fish respiration and the nitrification processes. Construction costs, initialization and use of such a system are small and do not require special knowledge, tools or skills. This system can be built and used in spaces where there is no possibility of using soil for plant growth (balconies, terraces, etc.). This way one can have available herbs, vegetables and fresh fish, even in an apartments building.

Keywords: aquaponics, construction, cost, soilless.

1. INTRODUCTION

Aquaponics is the combination between aquaculture and hydroponics. It combines the two in one integrated system that grows fish and plants together. In this system the fish eat the food, metabolise it and generate waste. This waste (mainly ammonia) are taken up by bacteria and transformed into substances available to plants. The plants use substances produced by bacteria and purify the water, so it can be used again and again. The only water used in an aquaponic system is the one lost through evaporation. This way an aquaponic system uses very little quantity of water comparing to aquaculture or hydroponics. If someone uses an aquaponic system have two benefits from it, namely fish and plants (vegetables, aromatic plants, ornamentals). The aquaponics systems may be of three types, namely: Nutrient Film Technique (NFT) is a commonly used hydroponic method, but is not as common in aquaponic systems. In NFT systems, nutrient rich water is pumped down small enclosed gutters; the water flowing down the gutter is only a very thin film. Plants sit in small plastic cups allowing their roots to access the water and absorb the nutrients. NFT is only really suitable for certain types of plants, generally leafy green vegetables, and larger plants will have root

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systems that are too big and invasive, or they become too heavy for the lightweight growing gutters. Media filled beds are the simplest form of aquaponics, they use containers filled with rock medium of expanded clay or similar. Water from a fish tank is pumped over the media filled beds, and plants grow in the rock media. This style of system can be run in two different ways, with a continuous flow of water over the rocks, or by flooding and draining the grow bed, in a flood and drain or ebb and flow cycle. Deep Water Culture works on the idea of floating plants on top of the water allowing the roots to hang down into the water. This can be done in a number of ways. This method is one of the more commonly practiced commercial methods. DWC can be done by floating a foam raft on top of the fish tank; however a more common method is to grow the fish in a fish tank and pump the water through a filtration system, and then into long channels where floating rafts filled with plants float on the water surface and extract the nutrients.

2. MATERIALS AND METHODS

The aquaponic system was built at the laboratory of Fisheries and Aquaculture of the Faculty of Animal Husbandry of USAMV of Bucharest. Type of system chosen: Media (river gravel) Filled Beds. The reasons for choosing this alternative: the media (river gravel) has multiple purposes, namely: it serves as a support for the plant, ensures the availability of nutrients to plant roots, ensures the availability of oxygen to plant roots, ensures aeration of water that flows back to the fish tank, provides bio filtration and nitrification and makes the water reusable for fish. To achieve all these goals the preferred method is the one of flooding and draining. This is achieved most simply by a siphon system.

Aquaculture component (Figure 1) consists of a tank with dimensions of 1.00m (L) x 0.62m (l) x 0.8m (h), resulting a total volume of 0.496 m^3, the volume of water will be 0.450 m^3 (450L).

Figure 1. Fish in Aquarium

Hydroponic component (Figure 2) is made of OSB, internally lined with 0.5 mm sheet folded into two layers, to prevent leakage. OSB is made of a parallelopipedic box with dimensions of 1.25m

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(L) x 0,85m (l) x 0.35M (h), thereby to obtain a plant growth area of 1.06 m^2 and a volume of 0 37 m^3. The box was filled with the graded gravel with size ranging from 8 to 16 mm. Gravel was used because it works to support plant roots and support the development of nitrification bacteria.

Figure 2. Hydroponic component

The water pump used was flow adjustable from 150 to 1000 l / h flow rate was adjusted to achieve a full cycle of filling and emptying of hydroponic component in half an hour. To achieve the cycle of filling and emptying of the hydroponic component, a bell siphon was used (Figure 3), the components of this are: PPR pipe 32 mm; PPR adapter 32 mm/1" exterior; PPR adapter 32 mm/1" interior; PVC pipe 75 mm, a thin flexible hose connected to the top of the PVC pipe was used to stop siphoning.

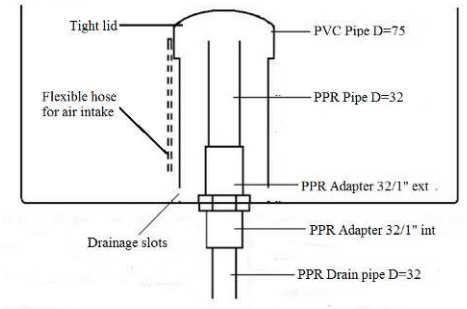

Figure 3. Bell siphon

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Oxygen enrichment of water was achieved using a high performance aerator with two diffusers and adjustable airflow that can reach up to 400 l/h (Figure 4).
The reason for choosing this aerator was motivated by the need of oxygen for growth and fish welfare and needs of nitrifying bacteria to oxidize ammonia and form the nitrates required plant growth.

Figure 4. Aerator

To ensure plant growth and photosynthesis the light was provided by a 600 W horticultural lamp (Figure 5).

Figure 3. Horticulture lamp

3. RESULTS AND DISCUSSIONS

At the end of the experiment was obtained a system with a plant growing area of one square meter and a volume of water for fish growth of 400 liters (Figures 6.7 and 8).
In this system one can grow different species of fish such as catfish, carp, ornamental fish species that are suitable for feeding pelleted feed (Figure 9).
Also in the hydroponics component of this system one can grow plants such as herbs, vegetables, ornamental plants.
Building such a system is relatively easy and can be accomplished in a relatively short time and with relatively low costs.

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The costs of building such a system, excluding the man work, are: parallelopipedic box made of OSB – 80 lei, Aquarium – 400 lei, Pump – 150 lei, Aerator – 170 lei, Pipes, adaptors, hoses – 30 lei, River gravel – 20 lei, Lamp – 200 lei, Total – 1050 lei (233 Euro).

Figure 6. Basil

Figure 7. Parsley

Figure 8. Peppers

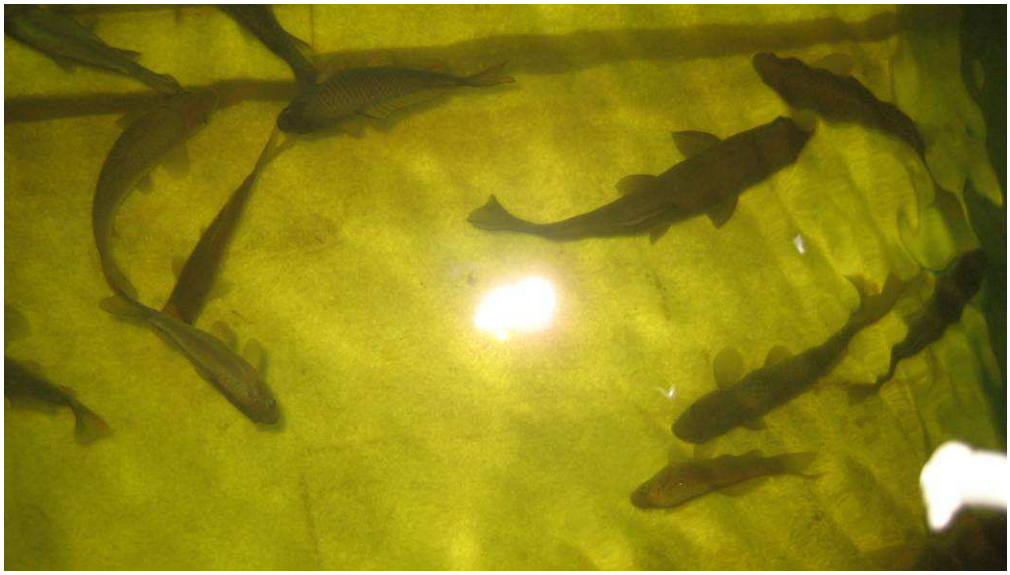

Figure 9. Fish in aquaculture component

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4. CONCLUSIONS

At the end of building the aquaponic system it has been found the following:

1. Aquaponic system building is relatively easy and does not require knowledge or special skills.
2. The cost of building a small-scale aquaponic system is relatively low.
3. Acvaponic system maintenance is easy and can be done by anyone.
4. One may enjoy getting fish meat and plants (herbs, vegetables, ornamentals) over a long period of time.
5. A small-scale aquaponic system requires no special spaces to be located (can be placed on the balcony of a building).

5. ACKNOWLEDGEMENTS

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