Current Trends in Natural Sciences Vol. 5, Issue 9, pp. 06-09, 2016

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

CASE STUDY ON WATER QUALITY CONTROL IN AN AQUAPONIC SYSTEM

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Abstract
Aquaponic systems are integrated systems that combine fish farming and different types of plants. It involves a dynamic interaction between fish plants and bacteria. Fish and plants are dependent the equilibrium of dissolved nutrients and water quality. Only by striking a balance between dissolved nutrients and water quality we can achieve a large production of plants and healthy fish. Thus, control of water quality in an aquaponic system is essential in order to obtain performance in raising fish and plants. The experiment was conducted in the laboratory of Fisheries and Aquaculture of the Faculty of Animal Science of the University of Agronomic Sciences and Veterinary Medicine of Bucharest within a period of 30 days. The system used for the experiment was designed and developed in the laboratory mentioned above. The plant used for water treatment in the system was basil (Ocimum basilicum). Fish species grown in the system was culture carp (Cyprinus carpio). Indicators measured to assess water quality in the system were: temperature, pH, dissolved oxygen, total ammonia, nitrites, nitrates and phosphates. The values determined pH 7.4-7.6, dissolved oxygen 8-10 mg / l, NH_4 0.05-05 mg/ l, NO_2 0.1-3.2 mg / l, NO_3 0-80 mg / l, 0.02-0.3 mg, PO_4 0.02-0.3 mg/l were not too high. In conclusion it was demonstrated that water quality in the aquaponic system studied is propitious to the growth and welfare of fish the registered values are not to be harmful.

Keywords: aquaponics, basil, carp, soilless, water quality

1. INTRODUCTION

Aquaponic systems are integrated systems that combine fish farming and different types of plants. It involves a dynamic interaction between fish plants and bacteria. Fish and plants are dependent the equilibrium of dissolved nutrients and water quality. Only by striking a balance between dissolved nutrients and water quality we can achieve a large production of plants and healthy fish. Control of water quality in an aquaponic system is essential in order to obtain performance in raising fish and plants.

2. MATERIALS AND METHOD

The experiment was carried on a period of 30 days, from February 26, 2016 to March 26, 2016 on an aquaponic system build and developed at the Laboratory of Fisheries and Aquaculture of University of Agronomic Sciences and Veterinary Medicine of Bucharest. The monitored parameters were:

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- Water Temperature - it is important to have a proper temperature for growth of the selected fish species and for plants as well;
- Dissolved Oxygen (DO) - it is very important to have enough dissolved oxygen to ensure fish breathing and to increase nitrification;
- pH - if the pH gets too near or above 7.2 in an aquaponic system the plants cannot absorb the nutrients in the system and creates a nutrient shutdown and your plants will begin to wither, show systems of leaf curl, begin to yellow, have stunted growth and not produce growth or blossoms. In effect, the plants are starving to death. The fish prefer a neutral pH.
- Ammonia - it is produced by gill excretion by the fish. It is found in water in two forms, unionized ammonia (NH_3) and ammonium ion (NH_4^+), which is summed as the total ammonia nitrogen. Its most toxic form to fish represents unionized ammonia. The form of ammonia is dependent upon temperature and pH.
- Nitrites – it is the second form in which the nitrogen can be found in an aquaponic system; it is rather toxic to fish and it is produced by the oxidation of ammonia by nitrifying bacteria.
- Nitrates – it is the end product of nitrogen oxidation, this oxidation is also made by bacteria. Nitrates are toxic to fish only in a large amount. This amount depends on the species of fish.

The kit by which analysis were carried out was a multiple parameter (Figure 1) kit produced by JBL. The kit can be found in aquarium stores. With this analysis kit multiple parameter tests can be carried out.

Figure 1. JBL Multitest Kit

3. RESULTS AND DISCUSSIONS

The experiment was conducted for a period of 30 days from February 26 to March 26, 2016. The species of fish stocked in the system was cultured carp (*Cyprinus carpio)* and the species of plant used in the system was basil (*Ocimum basilicum*). The water was tested every day for a period of 30 days. The parameters analysed on the aquaponic system were: pH, O_2 - Dissolved Oxygen, NH_3 – Ammonia, NO_2 – Nitrites, NO_3 – Nitrates, PO_4 – Phosphates. The results of the tests for pH, Ammonia, Nitrites, Nitrates, Phosphates, Dissolved oxygen are presented on Table 1.

Oxygen concentration values recorded throughout the experimental period were very high, exceeding the value of 9 mg/l. Since the saturation level of water in oxygen at a temperature of 22^{o}C is 8.33 mg/l and the temperature was constant throughout the experiment, a saturation of oxygen up to 115% in the growing medium.

This finding indicates that the fish have enough oxygen for survival and development, and the bacteria receive oxygen for the oxidation of ammonia, the nitrification is an aerobic process and has a maximum rate at water oxygen saturation above 85%.

pH values showed a neutral pH, slightly alkaline. These values indicate that the growth medium has a pH good for the fish. At these pH values one can achieve optimal nitrification, the required values for that are pH of 6.5-8.5.

Regarding the nitrogen compounds was found that the values for ammoniacal nitrogen (NH_3, NH_4^+) or of nitrite (NO_2) were not too high (Figure 2 and 3). These products may be harmful or even lethal to fish when their concentrations exceed certain values, namely, a concentration of 1,5 - 2 mg/l for ammonia (NH_4) and a concentration of 1.5 -2 mg/l nitrite for a longer period of time can be fatal for cyprinidae.

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Table 1. The results of the measured parameters in the experimental period

Day/Analysis	pH	NH_4	NO_2	NO_3	PO_4	O_2	Date
1	7.2	0.05	0.08	0.5	0.02	9	26.02.2016
2	7.2	0.05	0.08	0.5	0.02	9	27.02.2016
3	7.1	0.05	0.1	1	0.2	9	28.02.2016
4	7.3	0.05	0.1	1	0.2	9	29.02.2016
5	7.3	0.05	0.15	1	0.2	9	01.03.2016
6	7.2	0.05	0.15	5	0.2	9	02.03.2016
7	7.3	0.05	0.2	5	0.3	9	03.03.2016
8	7.2	0.05	0.5	5	0.3	9	04.03.2016
9	7.1	0.05	0.7	5	0.2	9	05.03.2016
10	7.2	0.1	0.9	10	0.2	9	06.03.2016
11	7.3	0.1	1	10	0.2	9	07.03.2016
12	7.2	0.1	3.2	10	0.2	9	08.03.2016
13	7.4	0.1	2.4	20	0.2	9	09.03.2016
14	7.3	0.2	2.4	20	0.2	9	10.03.2016
15	7.2	0.3	2	40	0.2	9	11.03.2016
16	7.3	0.3	2	40	0.3	9	12.03.2016
17	7.4	0.5	2	40	0.3	9	13.03.2016
18	7.3	0.5	2	40	0.2	9	14.03.2016
19	7.2	0.5	2	40	0.2	9	15.03.2016
20	7.4	0.5	2	60	0.2	9	16.03.2016
21	7.3	0.4	1	60	0.2	9	17.03.2016
22	7.2	0.3	1	60	0.2	9	18.03.2016
23	7.2	0.2	1	60	0.3	9	19.03.2016
24	7.3	0.2	0.5	60	0.3	9	20.03.2016
25	7.2	0.1	0.5	80	0.3	9	21.03.2016
26	7.3	0.1	0.5	80	0.3	9	22.03.2016
27	7.1	0.1	0.4	80	0.3	9	23.03.2016
28	7.2	0.1	0.2	80	0.3	9	24.03.2016
29	7.3	0.05	0.2	80	0.3	9	25.03.2016
30	7.1	0.05	0.1	100	0.3	9	26.03.2016

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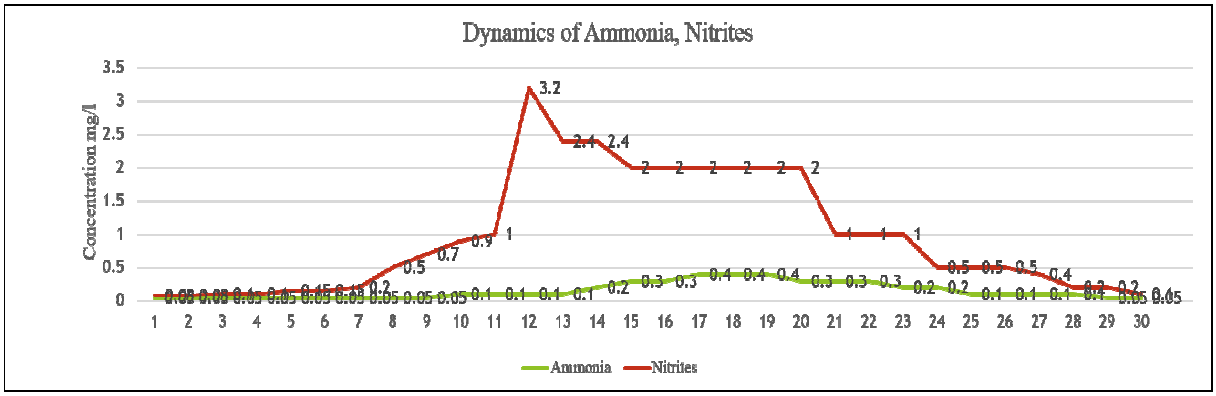

Figure 2. Dynamics of Ammonia and Nitrites

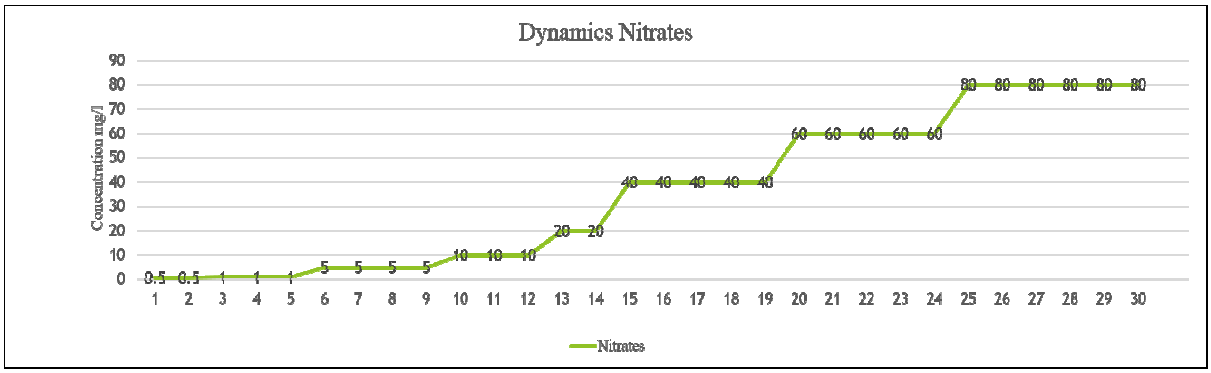

Figure 3. Dinamics of Nitrates

4. CONCLUSIONS

During the experimental period, it has been observed that the values of the parameters in the growth environment were nut to high and it is suitable for the fish, nitrifying bacteria and plants.

The values of measured parameters (pH 7.4-7.6, dissolved oxygen 8-10 mg/l, NH_4 0.05-05 mg/l, NO_2 0.1-3.2 mg/l, NO_3 0-80 mg/l, 0.02-0.3 mg, PO_4 0.02-0.3 mg/l) were favourable for the nitrification process, fish welfare and plants.

Following the results it can be concluded that an aquaponic system the growth environment is suitable for both fish and for the nitrification process which produces the necessary nutrients for plant growth.

5. ACKNOWLEDGEMENTS

This research work was a part from PhD thesis elaboration "Rearing some fish species in aquaponic systems" and was carried out with the support of Faculty of Animal Science, University of Agronomic Science and Veterinary Medicine of Bucharest.

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