MODERN TECHNIQUES OF URBAN FARMING BY TREATING KITCHEN WASTE WATER USING AQUAPONICS AND HYDROPONICS

K.Mahibah Farha

PG Scholar, Department of civil Engineering, Pandian Saraswathi Yadav Engineering College, Sivagangai,Tamilnadu, India

Abstract

Aquaponic and Hydroponic: Aquaponic refers to any system that combines conventional aquaculture (raising aquatic animals such as prawns, snails and fishes) with hydroponics (cultivating plants in water) in symbiotic environment. They both use nutrient rich water that's highly oxygenated to bathe the plants roots continuously and in both the systems, plants see better growth rates in comparison with those that are grown in soil. An aquaponic tank is designed by treating kitchen waste water is stocked with Tilapia fish (Oreochromis niloticus) and hydroponics species consist of tomato (Lycopersicon esculentum) and morning glory (Ipomoea purpurea).Basically an aquaponic system water from an aquaculture system is fed into a hydroponic system where the by products are broken down by nitrifying bacteria initially into nitrites and subsequently into nitrates which are utilized by the plants as nutrients and then water is recirculated back to the aquaculture system. Nitrogen recovery, pH, fish growth, DO, TDS and growth level of plant species in aquaponic and hydroponic system are determined at the end of the project.

key words:- *Aquaponic ,symbiotic ,oxygenated*

Introduction

1.1 General

Aquaponic is a food production system that combines intensive aquaculture (raising aquatic animals in tanks) with hydroponics (cultivating plants in a nutrient solution). The nutrient rich effluents from the aquaculture component are circulated through the hydroponic component where a proportion of these nutrients are taken up by the plants before the water is returned to the fish tanks. There is global concern about how future generations will produce more food sustainably. Agricultural has substantial environmental impact on natural resources, the conversion of natural land to agriculture; nutrient leaching and the use of chemicals are all serious issues. In the last 20 years nitrogen use in chemical fertilizers has exceeded by 20 times the nitrogen content in the oceans and brought severe eutrophication to water bodies. Closing the loop between crops and animals is therefore seen as the only way to improve water and nutrient efficiency and reduce wastes.

1.2 Hydroponics

Hydroponics comes from the Greek words hydro (water) and ponos (work). The growing of plants within a liquid or solid media (organic or inorganic) uses a wide range of dissolved macro and micronutrients, which are supplied in aqueous solution. There are three main types of hydroponic plant growing system that are also suitable as the plant growing component in aquaponic systems:

Nutrient film technique (NFT): A thin layer of nutrient rich water flows along a tube or closed gutter into which holes are cut and plants are placed, usually in small media filled plastic mesh pots. The upper part of the roots remains in the air while the lower part grows vigorously in the well aerated water.

Deep water or floating raft method: In which nutrient rich water is introduced to grow-tanks of 20-30cm depth, on the surface of which plants are grown through holes in polystyrene rafts. The water is vigorously aerated to maximize nutrient uptake.

Media based systems: where the plants grow in a medium such as gravel, clay balls, vermiculite, cinders etc. These beds may be "trickle fed" nutrient solution, or subject to periodic flooding and draining ("ebb and flow") to maximize exposure to both air and nutrients. The media beds also function as bio filters.

1.3 Aquaponic: Aquaponic, in which an aquaculture system is integrated with a hydroponic system, also has an ancient history. Plants have been grown using fish farm wastes either directly or indirectly. In one continuously recirculating unit, culture water exits the fish tank containing the metabolic wastes of fish. The water first passes through a mechanical filter that captures solid wastes, and then passes through a bio filter that oxidizes ammonia to nitrate. The water then travels through plant grow beds where plants uptake the nutrients, and finally the water returns, purified, to the fish tank. The bio filter provides a habitat for bacteria to convert fish waste into accessible nutrients for plants. These nutrients, which are dissolved in the water, are then absorbed by the plants. This process of nutrient removal cleans the water, preventing the water from becoming toxic with harmful forms of nitrogen (ammonia and nitrite), and allows the fish, plants, and bacteria to thrive symbiotically. The natural process of nitrification by bacteria that happens in aquaponic takes place in water the animal wastes are the fish excreta released in the culture tanks. The same nitrifying bacteria that live on land will also naturally establish in the water or on every wet surface, converting ammonia from fish waste into the easily assimilated nitrate for plants to use. Nitrification in aquaponic systems provides nutrients for the plants and eliminates ammonia and nitrite which are toxic.

The bio filter: Nitrifying bacteria are vital for the overall functioning of an aquaponic unit.

Two major groups of nitrifying bacteria are involved in the nitrification process: ammonia-oxidizing bacteria, *nitrosomonas bacteria* (AOB), and the nitrite-oxidizing bacteria, *nitrobacter* (NOB). They metabolize the ammonia in the following order:

AOB ⟶ NH_3 (ammonia) ⟶ NO2- (nitrite)

NOB ⟶ NO2- (nitrite) ⟶ NO3- (nitrate)

Recirculated aquaculture system:

A recirculated aquaculture systems (RAS), in which waste water is continuously recycled and returned back to fish after a bio-filtration.

Water treatment prior to recirculating to the fish includes:

- Mechanical waste removal (uneaten feed, fish solids, dead fish);
- Aerobic bio-filtration in which aerobic bacteria convert ammonia into non-toxic nitrate (nitrification);

Anaerobic bio-filtration in which anaerobic bacteria convert nitrate in water to free nitrogen gas (de-nitrification) which is released to the atmosphere

Methodology

2.1 General: The most important biological process in aquaponic is the nitrification process, which is an essential component of the overall nitrogen cycle seen in nature. Nitrogen (N) is a chemical element and an essential building block for all life forms. The methodology is adopted in this project is growing of plant species and fishes

2.1 Experimental setup: An aquaponic tank is designed in college environmental lab with Tilapia fish (*Oreochromis niloticus*) stocked within a hydroponic bed planted with tomato (*Solanum lycopersicum*) and morning glory (*Ipomoea purpurea*) together for 6 months. Fish were fed once per day and the feeding amount was determined based on fish response. Air pump was used to provide sufficient oxygen for fish growth by aerating the tank water and dissolved oxygen (DO) concentrations were maintained above 5 mg/L. The tank was covered with wooden board to prevent algal growth. Peristaltic pump was used to pump the fish tank water to a clarifier, which was built using 30-L sealed bucket filled with bio media. The clarifier captured majority of the suspended solids from aquaculture tank to protect the plant roots in the grow bed. After passing through the clarifier, tank water flowed into the grow bed. After 2 weeks,

Healthy plant seedlings were transplanted to the grow bed, nutrients present in aquaculture effluent were absorbed by plants in grow bed and the reclaimed water was then recirculated into the fish tank. Calcium hydroxide and potassium hydroxide were periodically dosed into the aquaculture tank to maintain the pH at a neutral range. Water samples were obtained from fish tank every other day after feeding, and were analyzed immediately for TAN, NO2-, and NO3- concentrations. DO concentrations, pH and temperatures were measured daily immediately after fish were fed.

Conclusion

Nitrogen uptake by plants played an important role in avoiding the accumulation of NO3 -in aquaponic. The present study showed that plant species had significant influence on nitrogen transformations in aquaponic. Higher NUE were obtained in tomato-based aquaponic, due to its higher abundance of nitrifying bacteria, which was associated with its higher root surface area. The N2O conversion ratios of tomato- and morning glory-based aquaponic were 1.6% and 1.8%, respectively, suggesting that aquaponic could also be an important source of anthropogenic N2O emission. Further research is necessary to improve NUE and minimize N2O emissions of aquaponic.

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References

1. *Rakocy, James E.; Bailey, Donald S.; Shultz, R. Charlie; Thoman, Eric S.* "Update on Tilapia and Vegetable Production in the UVI Aquaponic System" *(PDF).* University of the Virgin Islands *Agricultural Experiment Station*. Retrieved 11 March 2013.
2. "AQUAPONICS RESEARCH PROJECT" The relevance of aquaponic to the New Zealand aid programme, particularly in the Pacific Commissioned Report Prepared by Hambrey Consulting for New Zealand Aid Programme Ministry of Foreign Affairs and Trade.
3. Small-scale aquaponic food production Integrated fish and plant farming (Christopher Somerville et.al, 2014)
4. *Crossley, Phil L. (2004).* "Sub-irrigation in wetland agriculture" *(PDF). Agriculture and Human Values.* ***21*** *(2/3): 191–205.* . Retrieved April 24, 2013.
5. Integrated Agriculture-aquaculture: A Primer, Issue 407. FAO. *2001.* ISBN 9251045992.
6. *Tomita-Yokotani, K.; Anilir, S.; Katayama, N.; Hashimoto, H.; Yamashita, M. (2009). "Space agriculture for habitation on mars and sustainable civilization on earth". Recent Advances in Space Technologies: 68–69.*
7. "Carassius carassius". *Food and Agriculture Organization of the United Nations. Fisheries and Aquaculture Department*. Retrieved April 24, 2013.
8. *McCurry, M. R.; Nelson, P. V.; Sanders, D. C. (1988).* "Aqua-Vegeculture Systems". *International Ag-Sieve.* ***1*** *(3).* Retrieved April 24, 2013.

Bocek, Alex. "Introduction to Fish Culture in Rice Paddies". *Water Harvesting and Aquaculture for Rural Development. International Center for Aquaculture and Aquatic Environments. Archived from* the original *on March 17, 2010*. Retrieved April 24, 2013.