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Aquaponics for Food Production in Different Growing Beds

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***ABSTRACT:** Soil is the most preferred medium for growth of vegetation worldwide.An experimental investigation has been carried out to study the efficiency of a system to grow plants without the presence of soil called aquaponics .Aquaponics is the process of growing plants and fish and it is combination of hydroponics combined with aquaculture. Water from an aquaculture which is filled with nutrients is transferred to hydroponic system which is used by the plants as nutrient supplements and then the water is recycled back to the fish tank. Ammonia in fish waste will be broken down by bacteria which will be converted into nitrites and then to nitrates. Nitrates thus produced can be used as a natural fertilizer to grow plants.Two different types of aqua phonic grow mediumsuch as clay pebbles and coconut coir pith experimented and compared for two different crops usingaquaphonic technique.*

***Keywords:**. Fish, Aquaponics, plant, hydroponics, aquaculture, nitrates*

I. INTRODUCTION

Aquaponics system combines aquaculture and hydroponics whichsatisfies the need for nutrient-rich water for agriculture and the need for sustainable ways of filtering or disposing of nutrient-rich fish waste in aquaculture. Combining both the systems, a natural nutrient solution for plant growth can be providedby eliminating a waste product which is often disposed to wastewater.Endut et al. (2010), Graber, A. and Junge, R(. 2009) states that an aquaponic system has two different parts, the hydroponic system to grow plants and the aquaculturesystem to grow aquatic species. Because in most of the systems, only few species can survive.Selection of species will be based availability of space,yield,availability of nutrients in grow bed,they also have explained that microorganisms play a larger role in aquaponics with respect to productivity,waterquality,recycling of nutrients, control of diseases and controlling of effluents.Hargreaves, J. (1998) states that Nitrogen biochemistry is affected by the fish feedsand practices adopted for feeding, circulation of water, depth of grow medium,etc. Although the basic arrangement of an aquaponic system is so simple which involves only three types of living organisms such as fish, microorganism(bacteria), and the plants, the interrelations between these three are quiet complex. The system develops ammonia which is a toxic component which may affect the plants and bacteria. Intensive Research is going on to regulate the cycling of nutrients and pH levels. Fish feed is the biggest cost factor in intense aquaculture .Due to bad storage conditions, the fish feed gets contaminated easily which leads to serious health problems to fish and subsequently reduces the yield. Economical and other health benefits can be achieved by alternative fish feeds.

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II. MATERIALS ANDMETHODS

There are several system designs for recirculating aquaponics systems. The design is based on hydroponic systems, the only difference is the water source for the aquaponics system come from the fish tank and returned to its source of origin. Two different types of grow beds were used for this study with varying depths.Grow media serves as a support structure which keeps plants in an upright position. It also acts as a surface area for bacteria to grow forms a mechanical trap for the solid waste once it is expelled out of the fish tank and reaches the grow beds. For shallow rooted plants such as lettuces and greens shallow grow beds can be adopted whereas for deeply rooted plants such as tomatoes, cucumbers, corn, melons, etc. we require a deep medium.

The aquaponics system had one large fish tank where water is pumped from to fill the grow beds consisting of clay pebbles and coconut coir pith.Good water quality was maintained in the recirculating fish tank to maintain optimal growth conditions and healthy growth of the fish. The dimensions of the designed aquaponics system are as given in table 1.

Table 1. Dimension of the designed aquaponics system.

S.No	Description	Dimension
1	Fish tanks	100 L
2	Plantation area	0.025 m^3
3	Mechanical filter tank	10 L
4	Sump tank	150 L
5	Hydraulic loading rate	3.0 L/hr
6	Total water volume in system	400 L

Nitrifying bacteria, is an essential component for the nitrification process which converts animal and plant waste into nutrients required for plant growth.

The optimal pH value to be maintained in the water for the growth of these nitrifying bacteria should be in the range of 6-7.The nitrifying bacteria normally available in soil for plant growth also can live in water.

This bacteria converts ammonia from fish waste into nitrates eliminating the total ammonia produced which is a toxic material. The temperature of water also play a major role in the system for the bacterial growth, the optimal temperature found in the literatures was ranging between 17-34°C.The level of Dissolved Oxygen (DO)was also monitored regularly and maintained between 4–8 mg/litre.

Regular water quality testing was performed using a water quality testing kit.Fishwere largely responding well to commercial fish feed and their diets were well balanced in terms of amino acids, proteins, vitamins, minerals and carbohydrates. Fish were fed based on 5 minute eating period.

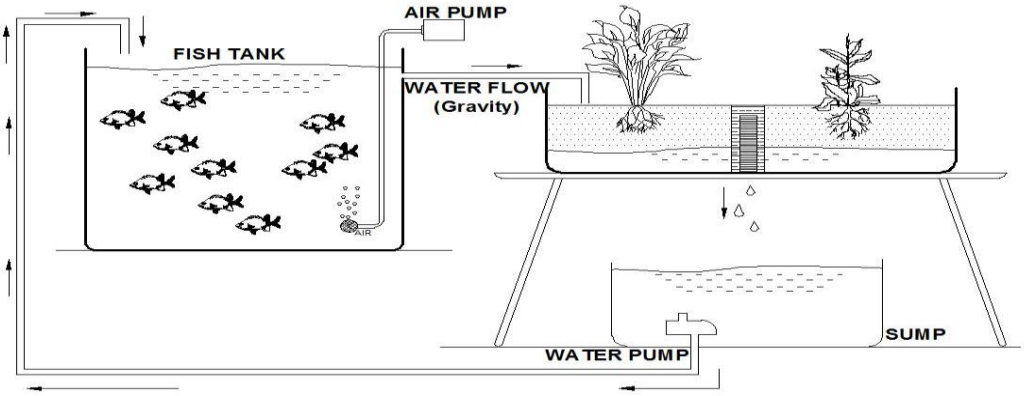

FIG 1.SCHEMETICDIAGRAM OF AQUAPONICS SYSTEM

III. DATA COLLECTION AND ANALYSIS

Maintenance and analytical data were collected every week. Maintenance data does not differ between beds and is used to maintain and improve the system over time. The parameters analysed during the experimental process includes pH levels of water nitrate/Nitrite levels, and temperature. Nutrient uptake is measured by not allowing the water to drain from the beds for 1 hour and then collecting water samples. Nitrate levels and air temperature were measuredin both the grow beds. Each growbed was seeded with 10 spinach seeds and 5chilli seeds in row formation. The dry weight of each bed wasalso measured.Dry weights of the shoot and roots were measured(S: R)by drying the plants in an oven at 65 degrees for a day. The pattern of growth was also observed with respect to time.Necessary precautions were also taken to maintain the pH level in water since fluctuations if any may make the medium acidic which in turn may affect the plant and fish growth. Anaerobic conditions may exist if the beds are not cleaned properly.

IV. RESULTS AND DISCUSSION

The purpose of the experiment was to observe how the grow beds perform by using a comparative analysis. The results of water quality parameters showed that the the available nutrients supports plant and fish growth in both the medium. The minimum, maximum and average temperatures for all the grow beds were measured and it was found that temperature of grow bed 2 was more than grow bed 1.The grow bed with coir pith yielded more than the clay pebble as grow bed as shown in fig 2.

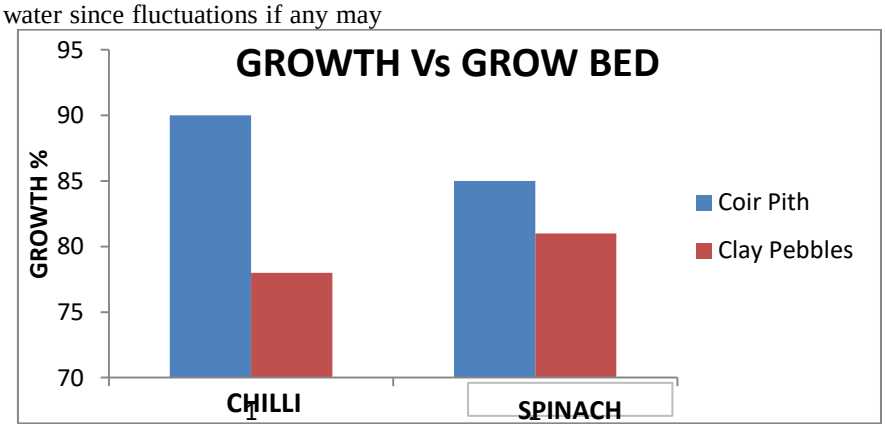

FIG 2.PERCENTAGE OF GROWTH OF CROPS VS GROW MEDIUM

It was observed that there was no deficiency in nitrates in the control beds from the water chemistry data collected. But there was gradual decrease in the concentration of nitrate content over a period of time.The general observations from both grow beds are listed in table 2.Due to the better water holding capability of coir pith,it showed quick growth than plants grown in gravel media.

Table 2.Comparitive chart of different grow beds

Description	Grow bed	
	Coconut coir pith	**Clay Pebbles**
Nature of roots	Roots were removed completely	Roots were present
Growth of plants	Healthy	Dries very soon
Microbial growth	At a faster rate	Quiet slow
pH	Neutral	Fluctuating
Transportation	Easy	Quiet difficult
Fish growth	Safe and fast growth	Dirt was more in medium leading to ill health of fish
Displacement of water	Low	Very high

It was observed that there was

Table 3 Water quality parameter for the different grow beds

Parameters (Average values)	Fish effluent	inlet	Water outlet	
			Coir pith	**Clay pebble**
pH value	6.3	6.4	6.6	6.7
Temperature(^{O}c)	28	30	29	28
Dissolved	6.3	6.1	6.8	6.0
Nitrates(NO_3)	55	99	99	101
Ammonia(NH_3)	8.7	6.9	1.56	2.11
Hardness of water(ppm)	84	84.3	84.3	84.3

The growth of plants in both the media were observed on a daily basis. It was found that the growth of plants in coir pith media was found to be faster than in the grow bed with gravels. Since the coir pith helped the plants to hold their roots tightly and the water retention in roots were better when compared to the other medium. The plants grown in coir pith as medium was found to be healthier and grown quickly than the other medium.

Limitations of Aquaponics

Though the aquaponics system had lot of merits, its major limitations on implantation are:

a. Initial Investment is quiet high when compared to the usual production of crops in soil.
b. Getting skilled labour with knowledge about fish and plant production is will be difficult.
c. Cannot be used under environmental conditions where there are severe fluctuations in temperatures and climate.
d. Operation of this system requires power,hence cannot be adopted in power shortage regions.

V CONCLUSIONS

The plants and fish grown in a coir pith medium is found to be more healthy and yield was high when compared to plants grown in clay pebble grow bed. The reason behind that is the pH of coir itself is neutral and it does not contain any dirt or dust. It can hold the roots firmly and helps the plant in getting the nutrients from the effluent.The water retention rate is high in coir pith as medium which helped the plant to grow without any delay in growth rate. This method of plant and fish growth can be adopted for income generation at houses since it does not occupies more space. The power requirement for the process setup can be easily addressed in power shortage regions through renewable sources of energy like installation of solar panels.

REFERENCES

1. Graber, A. and Junge, R,"Aquaponic systems: nutrient recycling from fish wastewater by vegetable production."Desalination246, 2009,pp.147-156.
2. Pietcsh C, Susanne K, Hana V, Sven D, Carsten S, Patricia B H and Ranka *JToxins* 7 ,2015,pp.3465-3480.
3. Pantanella, E., Cardarelli, M., Colla, G., Rea, E. &Marcucci, A. 2011. *Aquaponicsvshydroponics: production and quality of lettuce crop*. Acta Hort. 927.2015, pp._887–893
4. Roosta, H.R., "Effects of foliar spray of K on mint, radish, parsley and corianderplants in aquaponic system." Journal of Plant Nutrition, 37 (14),2014, 2236–2254.
5. Roosta, H.R., Hamidpour, M." Effects of foliar application of some macro-andmicro-nutrients on tomato plants in aquaponic and hydroponic systems.", Science.Horticulture. 129,2011,pp. 396–402.
6. Schmautz, Z., Graber, A., Jaenicke, S., Goesmann, A., Junge, R., Smits, T.H. "Microbial diversity in different compartments of an aquaponics system" Arch.Microbiology.199 (4),2017,pp. 613–620.
7. Seawright, D.E., Stickney, R.R. & Walker, R.B. " Nutrient dynamics in integrated aquaculture-hydroponic systems",*Aquaculture*, 160,1998,pp.215–237.
8. Watten B. Busch R, "Tropical production of tilapia (*Sarotherodonaurea*) and chillies(*Lycopersiconesculentum*) in a small-scale recirculating water system". Aquaculture1984; 41(3):271-283.

9. Yaghi, N., Hartikainen, H., "Enhancement of phosphorus sorption onto lightexpanded clay aggregates by means of aluminum and iron oxide coatings."Chemosphere 93, 2013,pp.1879–1886.
10. Yamamoto, T., Takaki, K., Koyama, T., Furukawa, K., Long-term stability ofpartial nitition of swine waste water digester liquor and its subsequent treatmentby anammox.",Bioresource Technology,2008,pp.6419–6425

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Dr.S.P.Sangeetha, Vice Principal Academics, Professor, Department of Civil Engineering is a Civil Engineer completed her Masters and Doctoral degree in Structural Engineering. Has wide experience in Teaching and Designing. She is a active member in Professional societies like American Concrete Institute, ISTE,IAENG,Chennai Civil Engineers ATCECEA,ACCE,ISTE,ACE,etc..She has delivered Technical lectures in various Institutions. She is the Programme Director for Institutional Social Responsibility cell to Inculcate Social awareness, values and environmentally responsible behaviour amongst students.She has received "Best faculty award "from DKRF and "Best recognition award "from Rotaract club of Chennai.

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