Zero Aqua Waste Management

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Abstract

Aquaculture is the farming of fish. Aquaponics is a system that mutually integrates aquaculture and hydroponics. It is an emerging technology that supports integrated aquaculture and vegetable production. In this, the feed required for 1 kg of fish is 4 kg. The main drawback in this technology is accumulation of ammonia, high fish feed, weekly water maintenance which in turn resulting in diseases to aquaculture and resulting in less effective processing. Biofloc is a modern technique for rearing aquaculture, to provide the fish with feed that is not a load on the environment the use of microbes as feed either filtrated directly from the water or recovered to become protein meal is very promising. Biofloc technology (BFT) is one method with filtration directly from water. It has traditionally been used in outdoor ponds that contain naturally photoautotrophic algae that provides the water with oxygen and becomes an additional food source to herbivorous and omnivorous species. This system is developed to prevent the introduction of diseases to aquaculture from incoming water and the feed required for 1 kg of fish is 1.2 kg, which is less than the above technology. Hence by considering the advantages of both technologies, we are adopting a new set up by combining the above two technologies resulting in Zero Waste Management. The combination of biofloc and aquaponics gives a new insight in to increasing the efficiency of food production which respects the sustainable agriculture. The integrated biofloc and aquaponics technology resulting in zero waste management.

Keyword- Aquaponics, Biofloc, Physico-Chemical Parameters, Zero Waste Management

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I. INTRODUCTION

Food is any nutritious substance that people absorb in order to maintain life and growth. Vegetables are considered essential for well-balanced diets since they supply vitamins, minerals, fiber, and phyto chemicals. Aquatic animal foods are a rich source of protein and have a lower caloric density, and have a high content of omega 3 long chain poly unsaturated fatty acids compared to land living animals. Fish is an important food stuff and source of protein all over the world.

In order to reduce the loss and maintain the quality of fruits and vegetables harvest, pesticides are used together with other pest management techniques during cropping to destroy pests and prevent diseases. The major concerns are their toxic effects such as interfering with the reproductive systems and foetal development as well as their capacity to cause cancer and asthma. Formalin is added to the fish, especially those come from bordering countries by the local fish traders to keep the fish fresh for a long time. But as it is a carcinogenic chemical and has got the ability to produce serious health hazards like cancers of the lung, nasopharynx, oropharynx and nasal passage to the population regulatory bodies of human.

Aquaponics is an appropriate technology that is socially acceptable because it creates necessary labour for handling the crops and fish and removes the major farming bottle necks; economically viable because it has proved to be financially rewarding in terms of costs vs. benefits; and technically feasible because the technology is readily available and easy to adopt. Aquaponics refers to any system that combines conventional aquaculture (raising aquatic animals such as fish, crayfish, prawns, snails etc. in tank) with hydroponics (cultivating plants in water without soil) in a symbiotic environment.

Bioflocs are aggregates (flocs) of algae, bacteria, protozoans, and other kinds of particulate organic matter such as feces and uneaten feed. Each floc is held together in a loose matrix of mucus that is secreted by bacteria, bound by filamentous microorganisms, or held by electrostatic attraction. The biofloc community also includes animals that are grazers of flocs, such as some zooplanktons and nematodes. Large bioflocs can be seen with the naked eye, but most are microscopic. Flocs in a typical green water biofloc system are rather large, around 50 to 200 microns, and will settle easily in calm water.

Zero waste management has gained attention as an innovated system to add value to water, recycle nutrients and waste in the system to produce more crops. Clubbing Biofloc and Aquaponics, the maintenance of water quality parameters for the existence of fish and plant morphology will be controlled. Suitability of this system can also provide better opportunities to full-fill the nutrition demand and to maximize use of land and water. Governments, businesses and individuals alike should therefore support and encourage the use of aquaponics at all levels by different strategies like biofloc.

II. MATERIALS AND METHODS

Zero waste is a whole system approach to resource management centered on reducing, reusing and recycling. To make recycling work for everyone, we need to by products from the materials we recycle. This reduces the need to utilize non-renewable resources by reusing material that have already been consumed. Producing recycled materials uses less energy and saves more money, materials etc. In this system the materials used are:

- Submersible motor
- Aeration motor
- Aggregates
- PVC pipes
- Siphon
- Bio ball
- Bio sponge
- IBC tank

For constructing fish tank of diameter 12 m and depth 10 m, we have excavated the ground at a depth of 1.5 m. The side of the fish pond is sealed with concrete and tank is fully covered with padutha sheet with flux. The fish tank consisting of venturi motor, kriloskar motor, submersible motor and consisting of 2000fishes. The bio-filter unit (IBC tank) is placed at a height of 1.6 m from the ground level. But the mechanical filter unit (IBC tank) is placed at 1 m from the ground level. The above two units are placed on concrete blocks. The growing bed and biofloc unit has a dimension of 2x1x1m, which is constructed on ground. The siphon inside the growing bed has a height of inner 5 cm, middle 20 cm and outer 30 cm. The growing bed is filled with aggregates (3/4 inch) at a height of 1 m.

Here, the water from the fish pond (continuous aeration) is pumped to bio-filtration unit with the help of submersible motor. In bio-filtration unit (continuous aeration) with the help of bio sponge and bio balls, the water containing ammonia (NH3) and hydrogen sulphide (H2S) will be converted into nitrite (NO2) by nitrosomonas bacteria. This process requires oxygen, destroys alkanity, produces acids (H+) and lowers pH. In bio-filtration unit the bacteria require surface area to make their home on. Hence bio sponge and bio balls will provide a attached medium for the growth of bacteria. Unfortunately, this establishing process takes time, and fish may be producing ammonia faster than the bacteria can keep up in newly started system. This is why it is advisable to slowly ramp up a new system and allow the bacteria to lead a time to have a large enough population to deal with the amount of ammonia produced when the system is at full capacity. Hence we choose biofloc unit as an alternative and effective option in our technology. From the bio-filtration unit when the water reaches to its maximum head it is drained out at a certain velocity to mechanical filtration unit. Mechanical filtration unit physically traps particles of uneaten food, fish waste, decayed plant materials and other debris in the water. This unit divided into inlet zone, settling zone, sludge zone, outlet zone (application of horizontal sedimentation tank). The inlet zone is provided with a 1 inch diameter at the bottom portion. In this process the water enters into the inlet zone from the bio-filtration unit and enters into the second zone (settling) through the bottom of the inlet zone. In the settling zone, suspended particles the deposited at the bottom (sludge zone) resulting in sludge, with in the time the water from the settling zone will flow to the next zone. The outlet zone will carry clean water with the presence of clarifier. This clean water is allowed to flow to the growing bed with the help of PVC pipe. As the water reaches the bed, the excess water will be drained out to fish pond by the application of bell siphon. At certain times the settled sludge from the sludge zone may be drained out continuously or intermittently from the tank to next unit.

The application of biofloc unit comes at this stage. The survival of the fish mainly need proteins, fats, vitamins etc. By introducing heterotrophic bacteria in this unit which is having high protein content, the fish growth will become more beneficial by continuous aeration. Here we introduce probiotics for the application of bacterial culture. By the usage of probiotics, the manual maintenance of floc formation under the presence of bacteria, algae, feces and uneaten feeds can be controlled. But for the survival of bacteria we have to add carbohydrates (starch, wheat flour) and carbon (jaggery) source content to the pond. By adding carbohydrate and carbon source in the pond, it act as a attached medium for bacteria and the manual fish feeding will reduce. The degradation process (Figure.1) is completed under both aerobic and anaerobic conditions but it has been shown that the aerobic pathway is much quicker. Therefore, it is very important that the water is aerated to provide a good environment to the culture. It has been shown that lack of oxygen is the first limiting factor. Bacteria and other microorganisms generate energy from cleaving carbohydrates (cellulose, sugars and starch) to produce proteins and new cells. Organic C = CO2 + energy + C assimilation in microbial cells. During aerobic condition, degradation of organic carbon by microbes to make new bacterial cells stands for 40-60% of the total amount organic carbon. As the sludge enters into the biofloc system, the heterotrophic bacteria decomposes the sludge into fish feed.

This treated water flows to fish pond with the help of bell siphon in the biofloc unit. The above treated water from the biofloc unit contain high rich protein content fish feed and floc (hetrotrophic bacteria) resulting in less manual fish feeding and in turn emerging in the active participation of nitrogen cycle with in the fish pond. This process continuous with cyclic manner under complete aeration (fish tank, bio-filtration unit, biofloc unit) and electricity.The design of our zero waste management is shown in Figure.2. The toatal area required for the setup is 10 cent (404.7m2) .Hence we have searched many farmers who were willing to adopt this technology. Later with the help of Sir Deliep we found farmer Sukumaran at Kodungallur. Our design mainly focus to optimize the use of agricultural resources of land, water, as well as labour, to make farming more sustainable along with recycling

and less feed to fishes. In this technology we are adding mechanical and bio-filtration units. These units play a major role in our Zero Waste Management Technology, as they initiate to club the Aquaponics and Biofloc systems.

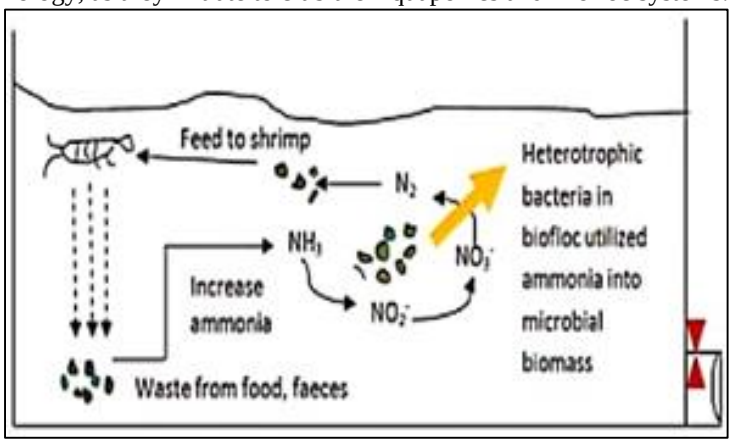

Fig. 1: Mechanism in Biofloc

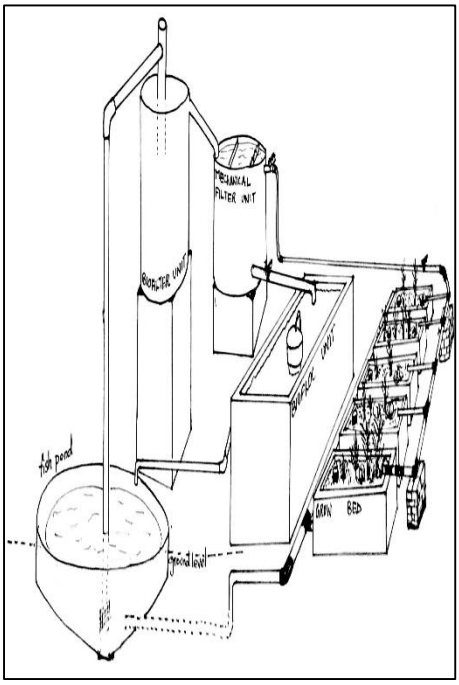

Fig. 2: Design of Zero Aqua Waste Management

Physico-chemical characteristics of water of zero waste management where studied monthly intrevals from January 2019 to April 2019 and we have taken average by choosing fixed sport by composite sampling method.
The physic-chemical parameters where analyzed by laboratory:

1) pH
2) Nitrate
3) Nitrite
4) Ammonia
5) DO
6) BOD
7) COD
8) Acidity
9) Chloride
10) Turbidity

III. RESULTS AND DISCUSSIONS

We have a detailed study about the technical set up, biological processes, variation in the morphological behavior of different variety of plants, fishes and analyzing the different water quality parameters of Aquaponics system at Cherai and Alangad, Biofloc technology at Thrissur and our new technology Zero Waste Management at Kodungallur. An attempt has been made to assess the suitability of physic-chemical characteristics of water at Cherai, Alangad, Thrissur.

A. pH

The ideal pH for the growth of fishes is between 7.5-8.5.In the present study pH at Cherai, Alangad,Thrissur, Kodungallur is 6.6, 6.8, 7.1, 7.0 .

B. Nitrate

Aquarium nitrate levels should be at a low rate well below 5 ppm. The ideal range for nitite is 0-40 ppm.At Cherai, Alangad, Thrissur, Kodungallur the nitrate is 19 ppm,20ppm, 10 ppm, 5 ppm.

C. Nitrite

The nitrite level should be at an undetectable level at all times. It is still a highly toxic chemical, and causes stree for fish even at levels as low as 0.5 ppm. Hence 0-40 ppm is the ideal range and at Cherai, Alangad, Thrissur, Kodungallur is 2 ppm, 1 ppm, 0.5 ppm, 0 ppm.

D. Ammonia

Ammonia is the princilple form of toxic compound. The ammonia content for aquatic organism should be zero. But in the present study ammonia level at Cherai, Alangad, Thrissur, Kodungallur is 3 ppm, 2 ppm, 0.5 ppm, 0 ppm.

E. Dissolved Oxygen

Oxygen is necessary to all life forms. The ideal range is 7.3-7.9. As DO level in water below 5mg/l, aquatic life is put under stress. The DO level at Cherai, Alangad, Thrissur, Kodungallur is 8 mg/l, 7 mg/l, 4.9 mg/l, 10 mg/l.

F. BOD

Biological Oxygen Demand is the amount of oxygen required for microbial metabolism of organic compounds in water. The optimum level of BOD for aquaculture should be less than 10 mg/l. In present study the value of BOD is ranged between 2.0-5.0 mg/l. But at Cherai, Alangad, Thrissur, Kodungallur is 7 mg/l, 9.5 mg/l, 3.25 mg/l, 1.3 mg/l.

G. COD

The Chemical Oxygen Demand of water represents the amount of oxygen required to oxidize all biodegradable, non-biodegradable and organic matter by a strong chemical oxidant. The ideal range for COD is 20-180 mg/l. The ideal value of COD should be less than 50 mg/l for aquaculture. In the present study the COD value at Cherai, Alangad, Thrissur, Kodungallur is 160 mg/l, 136 mg/l, 100 mg/l, 51.4 mg/l.

H. Acidity

Acidity is the tendency of a compound to act as an H+ donor. The ideal value for fish culture is 50-300 mg/l. In an In the present study the acidity value at Cherai, Alangad, Thrissur, Kodungallur is 360mg/l, 160 mg/l, 100 mg/l, 21 mg/l.

I. Chloride

Salts are used in a variety of aquaculture and for variety of purposes. The ideal range is 10-25 mg/l. In the present study the chloride value at Cherai, Alangad, Thrissur, Kodungallur is 42.48mg/l, 30 mg/l, 25 mg/l, 15 mg/l.

J. Turbidity

Turbidity refers to the decreased ability of water to transmit light.The ideal range suitable for fish culture is 20-30 NTU. But in the present study the value of turbidity Cherai, Alangad, Thrissur, Kodungallur is 9 NTU, 6 NTU, 43 NTU, 6 NTU.

IV. CONCLUSION

From the laboratory tests for physico-chemical characteristics of water quality of zero aqua waste management at Kodungallur has proven to be the most effective one as compared with aquaponics at Cherai, Alangad and biofloc technology at Thrissur. From our experience and several studies our technology is the most effective method as it have the following advantages as compared with other 2 technologies:

Extent the life span of fish.

- Ammonia control.
- Less manual feed.

- High stock density.
- High cultivation of plants.
- No water exchange

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