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Aquaponic Study and evaluation of Plant nutrient In Mung Bean and Alfalfa by using *Channa striata*

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Abstract

Aquaponics refers to any system that combines conventional aquaculture with hydroponics in a symbiotic environment. The aim this study was to use this technique i.e. to recycle fish wastewater to provide the vital nutrients for growing plants and with soilless plant culture and it acts as a natural fertilizer for the plant growth. The plants, fish, and bacteria in aquaponics systems entail adequate levels of water, temperature, pH, and dissolved oxygen for maximum growth. This method utilizes this wastewater mixture in growing beds converting them into nitrates. The present was quite successful, in using fish water waste in improving the nutrients for the plant growth of mung bean and *alfalfa* using aquaponic system. Carbohydrate and protein content of the two plants were estimated and was found to be similar to the regular plants grown using regular soil.

Key words : Aquaponics, mung bean, alfalfa, ammonia, murrel fish. proteins, Lowry method.

Aquaponics refers to any system that combines conventional aquaculture (raising aquatic animals such as snails, fish, crayfish, or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment. In normal aquaculture, excretions from the animals being raised can accumulate in the water, increasing toxicity. The effluent-rich water becomes toxic to the aquatic animal in high concentration but this contains nutrients essential for plant growth. One of the few studies on aquaponic production, by Goddek *et al.,*[3] states that some efforts have been made to set up systems, but commercial up scaling remains a challenge. The field of aquaponics is growing internationally, with more and more scientific aspects such as the efforts of pH on bacterial nitrification,[20]. The first reference to research in Europe was by Graber *et al.*,[4] but little is known about the types of facilities being used in the production of the fish, and crops being grown. Aquaponics systems are the nutrient flow and concentration within the different components (*e.g.*, aquaculture and hydroponics parts) are independent of one another and are called as decoupled aquaponics system (DAPS)[3] or double recirculation aquaponic system (DRAPS)[7]. Sprouts are nutritionally dense in protein, vitamins, and minerals because they are consumed just after emerging from the seed. Research studies have shown that their nutritional value can contribute to protecting against cancer and chronic disease[18]. Mung bean or green gram (*Vigna radiata*) have been widely cultivated by Indian farmers. Mung beans has short growth cycle (75-90 days), low-input crops, drought-tolerant, heat-tolerant (35°C), wider adaptability in almost all types of soil[1]. Moreover, the mung bean (*Vigna radiata*) has about 20%-24% protein and therefore, its consumption in combination with cereals can significantly increase the quality of protein in a meal[9,19]. It regulates the flora of enterobacteria, decreases the absorption of toxic substances, reduces the risk of hypercholesterolemia and coronary heart disease, and prevent cancer[8]. Apart from mung bean, another important plant which was considered for the present study, is Alfalfa (*Medicago sativa* L), which is frequently used in animal nutrition due to its high protein and fiber contents. It is also used as Ayurvedic Medicine and is well-known for its properties such as anti-cholesterogenic, rich in essential enzymes, minerals, and vitamins. and also known to prevent high blood pressure, diabetes, and peptic ulcer[11]. Apart from selecting these plants, to test the efficacy of aquaponic system, we have selected a commonly available fish, *Channa stratia* which is commonly known as haruan or snakehead murrel, an eminent tropical freshwater fish widely used for medicinal and pharmaceutical purposes[13]. Snakehead can survive in adverse environments with low dissolved and high ammonia[12,15,16], and due to its high market value, growth, tolerance of high stocking rates, and Utilization of atmosphere oxygen-depleted water are the characteristics of this striped snakehead that makes it desirable cultivar[17]. This study, was to undertaken, to understand the efficacy of aquaponics, using the fish in one tier and hydroponic cultivation of the plants in another tier, making use of fish effluent.

Alfalfa (*Medicago sativa* L.) and Mung bean (*Vigna radiata* L.). Seeds were purchased from a commercial store. The first two days before planting, the seed was soaked in water overnight and it grew in the dark place for germinating seeds. On the third day, the cloth was removed and ambient lighting was introduced. The Sprouts were irrigated for planting in the growing bed setup. Murrel fish (*Channa striata)* were purchased from Andhra Pradesh. The fish was maintained for 15 days in the laboratory conditions for the practical set-up. Further, it proceeds for the aquaponics method. This setup was beginning after 15 days in the laboratory conditions to maintaining the fish for the physicochemical activities. The 25-liter water can was taken and cut into two halves into a top and the bottom portion after which the top portion is covered with a cap in the opening so that the soil doesn't fall inside into the bottom portion. The bottom portion was made at the corners of both the top and the bottom portion and wooden sticks were tied to it joining the top and the bottom portion. There was a gap in between the top and the bottom portion and it was held by the wooden sticks using the plastic tag. The motor was then connected in the bottom portion of the can by using polyvinyl tubes and it was connected in such a way that the water flows upward when the motor is pumped, the water flows through the tubes it passes the top portion of the can then it flows into the grow bed. The fishes were introduced into the bottom portion, here we use small murrel fish and the fishes were feed with fish food, and sufficient electricity was required for the water supply through the motor to pump. The top portion was filled with soil manures, then *Alfalfa and Mung* bean germinated seeds were sprinkled and they are allowed to grow and were observed for 15-20 days. The fish water was pumped and used to water the seedling. The growth of the plants was observed and water was cleaned at regular intervals for the fishes to obtain minimal oxygen levels then control setups were made up with the normal trays. The trays were filled with the soil manures and then Alfalfa and mung bean germinated seeds were sprinkled and they are allowed to grow and observed for as same for aquaponic methods. They were maintained by normal tap water for their growth and observed. The nutrients, proteins and carbohydrates, were estimated using Lowry Method[10] by anthrone method, respectively. The results were obtained by using the statistical data analysis.

Estimation of Protein using Lowry's *Method*[10] *:*

One ml of sample was added to 1ml of deproteinsing agent of 80% ethanol and centrifuge at 3000 rpm for 5 minutes and decant supernatant was taken and dissolve the precipitate in 1ml of 1N NaOH and add 5ml of Lowry's reagent and mixed rapidly and after 10 minutes add 0.5 ml of follin's reagent and setup the blank simultaneously. From the standard solutions take 0.2ml, 0.4ml, 0.6ml, 0.8ml, 1.0ml in five different test tubes and make up to 1ml with 1N NaOH. Add 5ml of Lowry's reagent and mix rapidly. After 10 minutes add 0.5 foline Phenol reagent. Take 1ml of 1N NaOH for the s blank. After 40 minutes measure the optical density at 500nm. Carbohydrates was estimated by Anthrone Method (Hedge *et al.,* 1962).

Estimation of Carbohydrates using Anthrone Method :

Carbohydrates are first hydrolyzed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This compound forms with anthrone a green-coloured product with an absorption maximum at 630nm. 100 mg of the sample into a boiling tube. Hydrolyse by keeping it in boiling water bath for 3 minutes with 5ml of 2.5 N-HCl and cool in to the room temperature. Neutralize it with solid sodium carbonate until the effervescence ceases. And make up the volume to 100mL and then centrifuge. Collect the supernatant part and take only 0.5 and 1mL aliquots for analysis. Prepare the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1mL of the working standard. '0' serves as blank. Make up the volume to 1ml in all the tubes including the sample test tubes by adding distilled water. Then add 4mL of anthrone reagent in to it. And heat for eight minutes in a boiling water bath. Then allow it Cool rapidly and the colour changes green to dark green colour and find the optical density at 630nm. Mark the standard graph by plotting the concentration of the standard values on the X-axis versus absorbance on the Y-axis. From the plotted graph calculate the amount of carbohydrate present in the sample tube.

Table-1. Nutrient Analysis of Mung Bean in Aquaponics & Control

Nutrient	Control	Experiment
Protein	1.46 ± 0.206	1.56 ± 0.204

In this study, murrel fish (Channa striatia) and mung bean (Vignaradiata), Alfalfa seed (*Medicago sativa)* were cultured in lab-scale aquaponics, with easily available materials for the experimental work and the plant growth was observed and noted, the fishes were fed two times in a day. Throughout the study period, no death /disease of fish and also plants was observed. There are mainly three types of aquaponics systems: the grow bed method we have chosen for our study The fish wastewater, control water, and soil nutrients were analyzed for experimental purposes. The protein and carbohydrate values in mung bean and alfalfa sprouts were analyzed by using Lowry's and anthrone method and it was calculated by using the standard deviations by finding the optical density, then plot by using bar graph with differentiation of control and aquaponic sample. The control water was colorless when compared to the fish water which showed the color change from colorless to light brown. There was no odour found in the control water whereas, in the fish water the smell of the fish was identified (Table-1, Fig. 1). The fish and plants are dependent on the balance of dissolved nutrients and the quality of the water, as they generate and utilize metabolic products from each other. It is the unique balance that leads healthy animals to a productive crop. Because of the symbiotic uptake and release of nutrients from fish to plants, periodic monitoring of your aquaponic system water is essential. In the present observation compared to the control water the fish water has shown an increased level in all the parameters. The main reason for mung bean and alfalfa in control when compared to aquaponic samples is the increased growth factor in plants, these sprouts absorb nutrients completely from the soil so it results in depletion of nutrient level in the soil which results in the decrease root hairs or the root hairs are almost absent if the plant is exposed to the nitrous oxide/nitrogen concentrations of the least 100mg/l or high Phosphorus (221.36) content. Although the lower nutrient levels are also observed in the one-loop aquaponic system as compared to the hydroponic cultivation method. The results which are obtained in Mung bean by the following analysis was done and found that the aquaponics sample has a higher protein content (1.56± 0.204) of 1.87 % whereas the control had about 1.83% (1.46±0.206) proving how effective this method is (Table-2, fig. 2) and also the nutritional content in mung bean is increasing as compared to control. The following analysis was done same in alfalfa and the results are found that the aquaponic sample has a higher carbohydrate content of (1.77± 0.724) 1.88% whereas the control had about (1.36 ± 0.847) 1.71% proving how effective this method . when it results in the deamination of certain amino acids occur in the intestine of the rainbow trout after feeding. Fishes cannot store the excess amount of amino acids, unlike carbohydrates and lipids which can be stored as glycogen and triglycerides respectively. Deamination is used to break down the amino acids for energy production. Later, on amine group is removed from the amino acid and then converted into

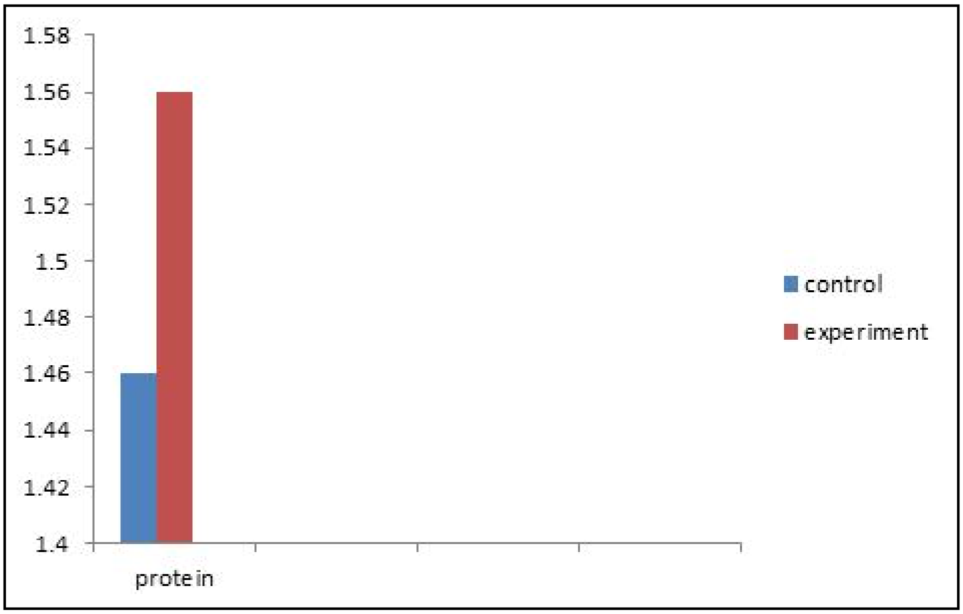

Figure 1: Protein Content in Mung Bean

ammonia. Some fish are producing a high amount of protein and lower amount of carbohydrate as same in the Murrel fish they have can withstand excessive ammonia production but due to limited space and environmental condition the fish does not tolerate and it leads to death. Thus, it produces an excess amount of ammonical nitrogen. Although, lower nutrient levels are also observed in the one-loop aquaponic system as compared to the hydroponic cultivation method. Most of the soil conditions provide the plant will be adapted to the climatic conditions and soil with sufficient nutrition for a complete life cycle, without the addition of nutrients as fertilizer. Thus, it results as even with adequate water, light, and nutrient deficiency can limit the growth of the plant and also decrease the crop yield production. Whereas this method has, natural biological cycles and control over it they also sustain the economic viability for farm operations; and enhance the quality of life for farmers and society as a whole[5]. In this method, fish are grown in the fish tank and then collect nutrient-rich wastewater from the fish tank. The benefits of this system include the reuse of the water from growing fish, and thus the production of two commodities from one system and saving the water usage and also prevents the soil conservation[2]. These findings indicate that currently about the aquaponics is primarily a niche or backyard, but the methods are highly scale able to the commercial systems if the basic principles are followed by the ratio of stocking density, feeding ratio, and also crop growing areas should be maintained. Aquaponics has Sustainable agriculture uses and is rapidly being embraced as a method of growing and producing food for farmers all across the globe. when Nitrous oxide emission of aquaponics is closely related to its nitrogen transformation and this emission factor also affected by many parameters in soil, including pH[20], temperature, DO fluctuation can be also observed[6]. Unionized ammonia fraction when pH was 6.0 and fish growth would not be influenced by nitrogen under this condition. Since ammonia oxidation was the first and rate-limiting step in nitrification, nitrogen dioxide produced by ammonia oxidation could be converted to Nitrate Nitrogen immediately. The end product of nitrification is also the main nutrient for plant growth in aquaponics.

The above study is a pilot it can be concluded from the affirmative results obtained from soil analysis, water analysis, and plant nutrient analysis. Hence mung bean, alfalfa seeds were used because it grows easily and much faster in 10-12 days when compared to other plants, and various types of plants and fishes can be also be used in this technique. In this method, murrel fish was used for the aquaculture part. Therefore, the world needs something that produces more food, at a faster rate-naturally. Many attempts at sustainable farming have been made, with various levels of success. But undoubtedly the shining star of them all is aquaponics. Aquaponics is improving in urban agriculture as an important part of the solution to increasing food shortages and the need for healthy food and it also plays a vital role for the land area and increasing global food security.

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