Vol 3 No 3 September 2022 Pages 40-46 e-ISSN 2708-5694

Journal of Agriculture, Food and Environment (JAFE)
Journal Homepage: http://journal.safebd.org/index.php/jafe
https://doi.org/10.47440/JAFE.2022.3308

Original Article

Assessing the Utilization of Waste from Aquaponics System as Nutrients Contributing to the Growth of Water Spinach and Tank Fish

Akter B[1*], Yeasmin H[2], Rayhan SM[3] and Khan MAU[4]

[1]Department of Aquaculture, Khulna Agricultural University, Khulna-9202
[2]Department of Agricultural Statistics & Bioinformatics, Khulna Agricultural University, Khulna-9202
[3]Interdisciplinary Institute for Food Security, Bangladesh Agricultural University, Mymensingh-2202
[4]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202

Article History

Received: 22 June 2022

Revised: 06 August 2022

Accepted: 14 August 2022

Published online: 30 September 2022

***Corresponding Author**

Akter B, E-mail: bablyakter@kau.edu.bd

Keywords

Aquaponics; water spinach and tilapia fish; SPSS

How to cite: Akter B, Yeasmin H, Rayhan SM and Khan MAU (2022). Assessing the Utilization of Waste from Aquaponics System as Nutrients Contributing to the Growth of Water Spinach and Tank Fish. J. Agric. Food Environ. 3(3): 40-46.

ABSTRACT

Due to having plentiful water resources, Bangladesh offers significant potential for fish farming. Aquaponics as a bio-integrated multi-trophic system that combines hydroponics (the growing of soilless plants) and re-circulate aquaculture (the culture of fish) to create a symbiotic relationship between fish, microorganisms and plants. This study was carried out for 95 days at the aquaponic laboratory of Khulna Agricultural University (KAU) to access the utilization of waste from tank water as nutrients affecting the growth of both water spinach and fish using two different medias-only bricklets (T_1) and mixture of bricklets and used tea leaves(T_2). For the purpose of growing vegetables and raising fish, six 20-liter plastic containers and a 750-liter water tank were employed respectively. Fish and water spinach samples were taken every two weeks. Electric conductivity (EC), carbonate (CO3), hydrogen carbonate (HCO3), total nitrogen (Total-N), phosphorous (P), potassium (K), sulphur (S), and sodium (Na) were measured in the soil testing Laboratory at KAU. Bacterial activity in the media and roots of plants was found to be higher in influent water than effluent water, indicating that plants were properly utilizing. "Microsoft Excel 2010" and Statistical Package for Social Science (SPSS) were used to analyze the descriptive statistics and determine the significance level as well. The greatest average plant measurements for T_1 were 36.40±3.55 cm in height, 58.81±23.35 in weight, and 93.90±38.52 in terms of leaves. In T_1 and T_2, a total of 1.57 kg and 1.21 kg of water spinach was harvested respectively. The length and weight gain percentages were 61.45 and 155.51 at the conclusion of the trial, while the survival rate and FCR were found to be 100% and 1.51, respectively and at the end of the study average fish production was estimated 9.91 kg. The technique actually produced more fish and vegetables while using less water causing no adverse effects on the environment. Through a symbiotic link between the fish and plants, the system effectively used fish waste in plant development and fish production as well. In order to address the environmental issues, the system might be placed in densely populated urban areas to grow fish and vegetables on rooftops and in backyards.

Introduction

Bangladesh has excellent fish culture potential because of abundant water resources. In 2017–18, the export of fish and fish products generated 1.5% of the country's foreign exchange earnings, while the fishing industry contributed 3.57% of the country's GDP, 25.30% of the agricultural GDP, and 1.5% of the latter.60% of the country's animal protein consumption comes from fish (DoF, 2020). This sector is also playing a significant role in socio-economic development to fulfill the demand of animal protein, opportunity for employment, environmental development, earning foreign currencies as well as poverty reduction.

Aquaponics is a method of producing food that combines aquaculture (the practice of keeping aquatic animals in tanks, such as fish, crayfish, snails, or prawns) and hydroponics (the practice of growing plants in water, such as hydroponic vegetables, flowers, and/or herbs). In this method, the nutrient-rich water from aquaculture is fed to plants grown hydroponically, where nitrifying bacteria transform ammonia into nitrates (Rakocy *et al.*, 2012; Baganz *et al.*, 2021). The system is frequently referred to as environmental engineering excellence. After that, water that has been almost entirely cleaned of ammonia, nitrates, nitrites, and phosphorus is recirculated back into the fish tank from the hydroponic beds and bio filter (Goddek *et al.*, 2015). Dissolved nutrients from fish waste contribute to an increase in plant biomass, which in turn lessens the environmental effects of food production on land (Ghaly *et al.*, 2005). Through this integration, some of the unsustainable aspects of operating aquaculture and hydroponic systems separately are eliminated (FAO, 2014). There is less need for biological or chemical filtration when maintaining water quality and modifying the water since the waste is utilized by the plants as a source of nutrients, which helps flush any dissolved waste from the system (Endut *et al.*, 2009). Water quality is also the most crucial environmental factor to take into account in this culture since it has a direct impact on aquaculture productivity. As they directly affect human health, it is also essential to maintain and produce high-quality lucrative products. Consequently, any decline in water quality will have an impact on how cultured organisms evolve, expand, breed, and possibly even die (Ekubo and Abowei, 2011; Eissa *et al.*, 2015). Among others, an aquaponic system makes it simple to grow a wide range of plants, like-water spinach, indian spinach, tomatoes, mint, cabbage, capsicum, lettuce, and cucumbers. A lovely vegetable with green leaves, water spinach has received a lot of attention as a novel source of bioactive chemicals that are beneficial to human health (Lakshmi and Vimala, 2000). Since water spinach is a healthy vegetable, it is frequently grown in contaminated water, which is bad for people's health. Conversely, fish with great growth potential and tolerance for a variety of water quality parameters are ideal for aquaponic system production (Johanson, 2009). The main objective of this study was to determine how fish tank waste can be used as nutrients to help with water spinach production and then fish production when tank water is transformed into purified water.

Materials and methods

Study area and experiment duration

The study assessed the production of water spinach and fish in an aquaponic system utilizing two different media for a 95 days period, from June 5 to September 8, 2021, in the Aquaponic Laboratory of Khulna Agricultural University (KAU), Bangladesh.

Experimental layout

There are many other kinds of aquaponic systems, however the media-based aquaponic system was selected to carry out the current experiment. A fish holding tank and six media containers made of food-grade plastic make up the study's design. In this experiment, two types of media were utilized: bricklets mixed with used tea leaves (8–10 cm in size) and bricklets alone (1:1 by volume). For the treatments, every bed was the same size (43.7 x 26.8 x 24.5 cm3). The approved treatments were T_1R_1, T_1R_2, and T_1R_3; T_2R_1, T_2R_2, and T_2R_3 (*Figure 1*). The circular fish tank measured 68 cm by 51 cm in size (750 Volume liters). In order to provide oxygen to the fish tank, two 10 watt air pumps with two ports each equipped with four air stones were used. A 12 watt submersible water pump irrigated the vegetable bed with fish tank waste water.

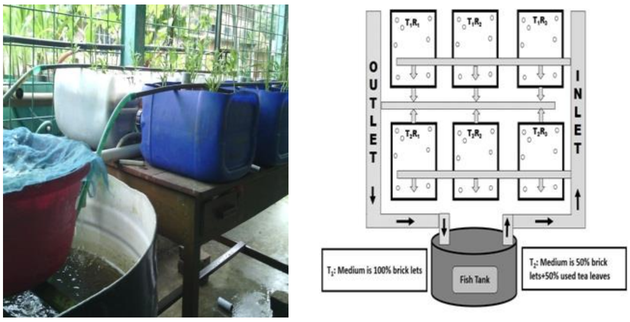

Figure 1. Experimental design of the study.

The tank has pipes for an inlet and an outlet. The system was circulating water. The plastic pipe, on which containers containing plants were set, was joined by two little PVC pipes. A water pump was used to circulate contaminated water from the fish tank through small pipes that were joined to the end of the plastic pipe. A PVC line connected each container, and a plastic pipe was attached to the outlet pipe to drain the fish tank's water.

Setting up the fish tank

Before beginning the experiment, the fish tank was prepared by being purchased from a nearby market. The tank had to be cleaned, limed, and have plumbing pipes installed. Bricks had to be set, and the tank had to be filled with groundwater. The upper part of the tank was initially removed to make room for a feeding and cleaning entry. The tank was then cleaned using water that was disinfectant-infused. Before beginning fish culture, the fish tank must be thoroughly cleaned to get rid of any chemicals. An inlet and outlet were made using the pipes. Four air stones and two air pumps were set up to provide and dissolve oxygen. After that, the tank was filled to the bottom with bricklets that ranged in diameter from 2 to 5 cm. Before placing the brick lanes, clean water was used to wash them, and then water from an above-ground tank was utilized to fill the tank. Separate filters were used to collect and place the fish tank's water on top.

Fish stocking

Mono sexual tilapia fingerlings were used as the research subjects in a different aquaponic experiment. They were obtained from a nearby hatchery. The fish that had been gathered were acclimated before being released into the test tank. The experiment used fingerlings that were in good health. The fingerlings were cleaned with potassium permanganate solution (2 mg/L for 4–5 hours) prior to stocking. Fish were acclimated for 15 minutes for every degree of temperature change and every unit of pH change before fingerlings were released. On June 5, 2021, 60 tilapia fingerlings were introduced into the tank after acclimation.

Fish feeding

The fish were fed the commercial floating feed (1--3 mm size), which included 30% protein. The meal was purchased from the neighborhood fish vendor in Khulna. Initial administration of the meal was twice daily at a rate of 3%

body weight, with the first administration occurring at 9:00 AM and the second at 5:00 PM. Overfeeding was avoided because uneaten food degrades water quality and renders fish tank water unhealthy. Later, the fish was fed 3% of its body weight.

Fish sampling

The first sampling was conducted on June 5, 2021 during releasing time. It was done every two weeks. The sampling method was a scoop net. No fish feed was being given to them at the sampling time. From the tank, ten fish were chosen at random and put into another bucket with aerators. The ten fish were then carefully weighed and measured for length. Weight was measured using an electronic compact balance (KD-S/F-en), and length was measured using a measuring scale (Figure 2). The information was meticulously recorded. The fish were put into the aquarium right away when the recording was finished. On September 5, 2021, the final sampling was conducted. At the last sampling, all fish were captured and weighed and measured for length.

Figure 2. Weighting the sampled fishes

Physico-chemical parameters of the water in tank

To assess the quality of the water, the physico-chemical properties of tank water were tested. Temperature, pH, and dissolved oxygen (DO) were measured every 15 days. Chemical test kits were used to check these properties. Throughout the study, three measurements of total nitrogen (Total-N), electric conductivity (Ec), carbonate (CO3), hydrogen carbonates (HCO3), potassium (K), sulphur (S), sodium (Na), and calcium (Ca) were made at one-month intervals. The tests were conducted Soil Testing Laboratory at KAU.

Factors for growth

The length gain (cm), weight gain (g), percent weight gain, specific growth rate (SGR), food conversion ratio (FCR), survival rate (%), and fish production (kg/ha) metrics were employed to measure the growth of fish.

Gain in length

The fish length gain was measured following the formula:
Gain in length (cm) = mean final length (cm) – mean initial length (cm)

Gain in weight

The weight gain of the harvested fish was measured with the formula:
Gain in weight (gm) = mean final weight (gm) - mean initial weight (gm)

Percent gain in length

This is fairly the measure of the total rise in the mean body length during a time period.

$$= \frac{Mean\ final\ length - Mean\ initial\ length}{Mean\ initial\ length} \times 100$$

Percent gain in weight

This is fairly the measure of the total rise in the mean body weight during a time period

$$= \frac{Mean\ final\ weight - Mean\ initial\ weight}{Mean\ initial\ weight} \times 100$$

Specific growth rate (SGR)

The percentage increase in body weight over a given time period used to calculate the immediate change in fish weight is known as the specific growth rate. The specific growth rate (SGR) was calculated using the following formula:

$$\text{SGR(\% per day)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \times 100$$

Here, W_2 = Mean final weight (g),
W_1 = Mean initial weight (g), and
$T_2 - T_1$ = Length of experimentation period

Food conversion ratio (FCR)

The formula below was used to calculate FCR as the ratio of food consumed to weight increase:

$$FCR = \frac{Amount\ of\ dry\ feed\ (kg)}{Weight\ gain\ (kg)} \times 100$$

Survival rate (%)

The number of fish harvested from each treatment at the end of the experiment and those data at the beginning of the trial were used to compute the fish survival rate.
The formula below was used to get the survival rate:

$$Survival\ rate = \frac{No.of\ fish\ harvested}{No.of\ fish\ stocked} \times 100$$

Fish productivity

For the purpose of calculating the production of fish in the treatment, the mean increased weight (gm) of each fish was multiplied by the total number of fish. The formula used to calculate production was as follows:

$$Fish\ productivity = number\ of\ caught\ fish \times increased\ weight$$

Bed preparation for water spinach culture

As a water spinach culture bed, affordable, locally convenient and high-quality food grade plastic containers were used. Six plastic containers were purchased from the neighborhood market. The cane measured 43.7 x 26.8 x 24.5 cu cm in size. Each cane's upper side was removed using a sharp knife. Each plastic cane was given a single pore on one side to create an outlet for recirculation of water 3 inches above the cane's bottom. Before usage, they were professionally cleaned and allowed to air dry. A further 15% of the space was reserved for maintenance and the plastic canes were arranged side by side.

Brick lets media

From a local brickyard, bricks were bought. They were hammered down to 2-3 cm in size. Brick pieces were meticulously cleaned before being incorporated into the canes. Three plastic canes with the labeled T_1R_1, T_1R_2, and T_1R_3were filled with the bricklets.

50% brick lets and 50% used tea leaves

Brick fragments were acquired locally for the test. Bricklets were between 2 and 3 cm in size. They were well cleaned. We collected used tea leaves from a nearby tea business. The identical quantity of old tea leaves and bricks were layered into three containers with the labels T_2R_1, T_2R_2, and T_2R_3 (measured in volume). Then, the containers were kept next to one another on a bamboo support outside the Aquaponic lab. A PVC pipe was punctured with a drill machine and later used to give water to the vegetable beds.

Planting of sapling

Saplings of water spinach were taken from the Horticulture Center of Daulatpur and planted on it after the media had been placed inside the plastic cane. The experiment's plantation was made up of 5 cm tall kolmi seedlings. In total, 24 seedlings were planted. Four saplings were planted in each of the four corners of each bed. On June 12th, 2021, the planting was finished.

Watering

Watering was initiated when planting was finished in the media-contained containers. Water from the fish tank was solely utilized for watering. The plants were watered using permeable PVC pipe. The pipes were regularly cleaned in order to supply as much waste water as possible. A motor was used to move plant water from the fish tank to the beds. The supply of waste water was shut off at night. No fertilizer was applied to the vegetable plots. After a slow increase in denitrifying bacteria in the beds over the first 10 to 15 days, nitrification started in full force.

Plants successfully thrived after that. Although it is regularly done when unwanted plants start to develop in aquaponic systems, weeding is typically not as important there.

Harvesting

After 15 days of germination, water spinach plants are ready for harvest.

Gathering data on plant growth

The experiment's goal was to assess how well two different media produced water spinach in an organized aquaponic system. In order to conduct an adequate study, data on plan growth (height, weight, and leaf count) was recorded.

Plant height

It was measured every two weeks interval. Heights were measured from the top of the main plant stem to the top of the bedding material in the container (Figure 3). The measurement was performed using a measuring scale. The plants were cut by 5 cm just above soil amendment after being measured.

Count of the plant leaves

Leaves on each plant were counted and recorded the overall number. It was methodically counted and documented how many leaves there were on the plant, including the new ones just beginning to grow.

Plant weight

The water spinach plants were picked every two weeks by slicing through the stems with a knife after measuring the plant height and leaf count. At the time of harvest, plants were weighed using an electric balance. At the end of the trial, plants and their roots were taken for weighing (Figure 3). A notebook was used to properly record each weight.

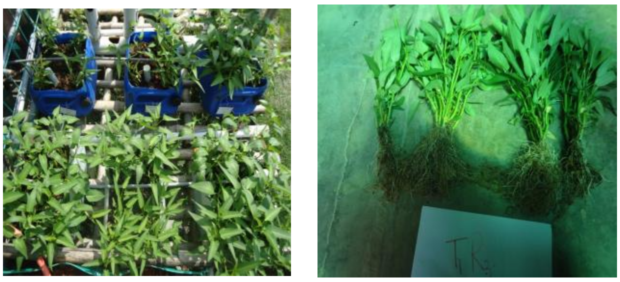

Figure 3. Collection of plant data at the end of the experiment.

Data processing and analysis

For data entry, "Microsoft Excel 2010" was utilized. Data from the collection were thoroughly summarized before final tabulation. Initial data were recorded into a master spreadsheet and organized into tables and figures to show the experiment's outcomes. Data analysis using descriptive statistics was done using "Microsoft Excel 2010" when data entry was complete. The significance level of the treatments' data was also determined using the Statistical Package for Social Science (SPSS).

Results and Discussion

Lab test results of fish tank water

The Laboratory at the Soil Science Department of KAU measured the following variables twice, one month apart: electric conductivity (EC), hydrogen carbonate (HCO3), carbonate (CO3), total nitrogen (N), phosphorous (P), potassium (K), sulphur (S), and sodium (Na). Following are the test's findings for the fish tank's water.

Table 1. Results of the two-month testing of tank water and outlets (1, 2).

Elements	July			September		
	Inlet	Outlet-1	Outlet-2	Inlet	Outlet-1	Outlet-2
EC (µs/cm)	548± 2.00	609.33± 5.13	618.33± 2.00	618.00± 2.00	760.67± 2.52	408.67±7 .09
HCO3 (ppm)	202.27± 7.80	190.67± 4.16	111± 4.58	210.88± 4.30	208.17± 2.75	318.20±2 .71
CO3 (ppm)	60.33± 1.53	21±3	109.67± 5.69	20.67± 3.06	50.33± 2.52	0
Total-N (ppm)	4.70± 0.66	5±0.20	4.17± 0.40	15.30± 0.46	8.20± 0.26	0
P (ppm)	0.76± 0.12	0.45± 0.07	0.07± 0.06	1.06± 0.15	0.14± 0.01	0.01±0
K (ppm)	13.23± 0.35	10.20± 0.30	12.35± 0.43	11.85± 0.31	2.26± 0.26	5.03± 0.12
S (ppm)	2.17± 0.22	0.98± 0.06	1.02± 0.03	7.23± 0.26	2.30± 0.45	2.62± 0.45
Na (ppm)	38.53± 0.93	34.50± 1.35	40.45± 1.06	No test	No test	No test

Note: (1) Values are given with ± standard deviation; (2) Outlet-1: Only brick lets Media, Outlet-2: Mixture of brick lets and used tea leaves based media

Electric conductivity of the water in tank

Electric conductivity, a measure of a solution's ability to carry an electric current, reveals the quantity of dissolved electrolyte ions' presence in the water. Furthermore, there are noticeable increases in conductivity when there are sufficient nutrients for the growth of the plant. Higher conductivity typically denotes the presence of helpful ions for growth of the plant, such as sodium, phosphate, and nitrate. In September, outlet-1 water's electric conductivity measured at 760.67±2.52 (µs/cm), which is the highest number ever recorded. According to Rodriguez-Delfin *et al.* (2000), the EC for lettuce should not be higher than 2500 (µs/cm). However, in this study, the EC in the aquaponic system was 618.00±2.00 (µs/cm) in the inlet water and 408.67±7.09 (µs/cm) in the outlet water, indicating that the plants in the system were properly utilizing nutrients (Rakocy *et al.*, 2004).

Hydrogen carbonates analysis

Nitric acid (HNO3) is produced while processing the nitrification. This acid is decomposed in water into hydrogen ions (H+) and nitrate (NO3-), with the latter serving as a supply of nutrients for plants. Due to the process of nitrification, the higher the concentration of HCO3 in the water, HCO3 works longer as a pH buffer to keep the system from becoming acidic (Somerville *et al.*, 2014). In this investigation, it was observed that the HCO3 level in the tank water was low at the trial's opening phase (202.27±7.80 ppm), and that by the end of the study, for the reasons mentioned above, the HCO3 concentration had increased to 318.20±2.71 ppm.

CO3 of fish tank water

The amount of carbonate (CO3 2-) and bicarbonate (HCO 3-) dissolved in water is very important indicator for fish culture. It is also measured in milligrams of CaCO3 per liter. In general, water is considered to have high level of bicarbonate (121–180 mg/L) (Somerville *et al.*, 2014). The highest CO3 reading was 109.67±5.69 ppm in outlet-2 in July, and the lowest reading was 20.67±3.06 ppm in intake in September. However, outlet -2 did not have any CO3 at that time.

Total-N analysis of fish tank water

The fourth important water quality parameter that comes into the aquaponic technique from fish feed and other wastes is nitrogen. Nitrogen compounds are the main ingredient in plant fertilizers, while being poisonous to fish. In an aquaponic system, ammonia and nitrite levels must be between 0.25 to 1.0 mg/L, or nearly zero (Somerville *et al.*, 2014). In this investigation, it was observed that the total-N level started off relatively high (4.70±0.66 ppm) before progressively declining to 0 ppm. The reason for this was that the grow bed's bacterial activity favored the fish growth in tank.

Phosphorus analysis

The intake water's September reading of 1.06±0.15 ppm for phosphorus was the highest ever recorded. The lowest reading, in comparison, was 0.01±0 ppm discovered in outlet-2 in the same month.

Potassium analysis

The input water's potassium content peaked in July at 13.23±0.35 ppm, while the values at outlets 1 and 2 were 10.20±0.30 ppm and 12.350.43 ppm, respectively. While outlet-2 was 5.03±0.12 and inlet was 11.85±0.31 ppm, outlet-1 had the lowest value of 2.26±0.26ppm in September.

Sulphur analysis

From the analysis it was observed that both highest value of Sulphur found in inlet which was 7.23±0.26 ppm in September when in outlet- 1 it was 2.30±0.45 ppm and in outlet-2 the value was 2.62±0.45 ppm during that time.

Sodium analysis

Inlet water had a sodium value of 34.50±1.35 ppm (lowest) and outflow water had a value of 40.45±1.06 ppm (highest), both of which were discovered in July. No test was done for Na in September due to insufficient chemicals in the laboratory.

Plant growth

While conducting this experiment, measurements of the plant's growth (height, weight, and number of leaves) was made. Data on plant growth (height, weight, no. of leaves) are shown in Figure 4.

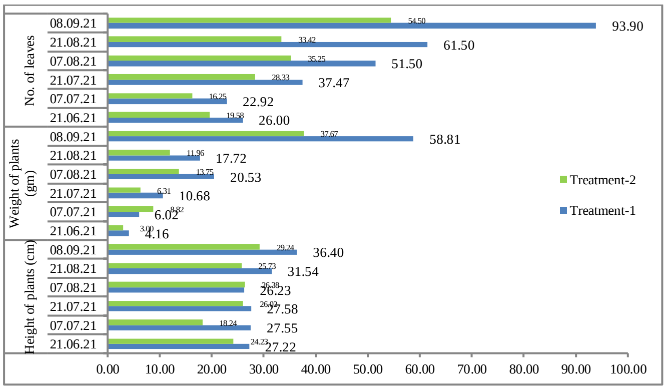

Figure 4. Observation of the plant growth (height, weight and number of leaves) while conducting the experiment.

Height of the plant

Heights of the water spinach were recorded regularly after planting at intervals of 15 days. On 8th September in treatment T_1, during harvesting the plant with the highest average height was measured at 36.40±3.55cm (Table 2). It was 29.24±8.22 cm at the same time in treatment group T_2. As per statistics, no acceptable variations in plant height between the two treatments were observed.

Table 2. Observation of the plant growth in two different treatments.

Date	Height (cm)		Weight (gm)		No. of leaves	
	Treatment-1	**Treatment-2**	**Treatment-1**	**Treatment-2**	**Treatment-1**	**Treatment-2**
08.06.21	27.22±5.05	24.23±4.05	4.16±2.38	3.00±0.81	26.00±6.22	19.58±3.11
07.07.21	27.55±4.11	18.24±2.19	6.02±3.03	8.82±2.75	22.92±2.93	16.25±5.77
21.07.21	27.58±3.49	26.02±3.12	10.68±3.97*	6.31±10.11*	37.47±9.35	28.33±3.92
07.08.21	26.23±3.44	26.38±2.51	20.53±3.77	13.75±9.00	51.50±12.63	35.25±10.63
21.08.21	31.54±1.89	25.73±3.70	17.72±4.07*	11.96±4.97*	61.50±26.56	33.42±14.62
08.09.21	36.40±3.55	29.24±8.22	58.81±23.35*	37.67±32.43*	93.90±38.52	54.50±24.76

**Mean values are significantly different (p<0.05)

Plant weight

The weight of the leaves varied significantly (P=0.05) among the treatments as of July 21, August 21 and September 08. In the other dates, there is no discernible change in the weight of the leaves. On 8th September in treatment T_1, at the day of harvesting the average plant weight that was found to be the highest was 58.81±23.35 cm (Table 2). It was 37.67±32.43 cm at the same time in treatment group T_2.

No of leaves

Counts of plant leaves were made prior to harvesting at intervals of 15 days. The T_1, area had the highest average number of leaves, 93.90±38.52, on the harvesting day (8th September).In the same moment, it was 54.50±24.76 cm in the treatment group T_2. But based on the statistics, there were no significant differences height of the plant between the treatments.

Total water spinach production

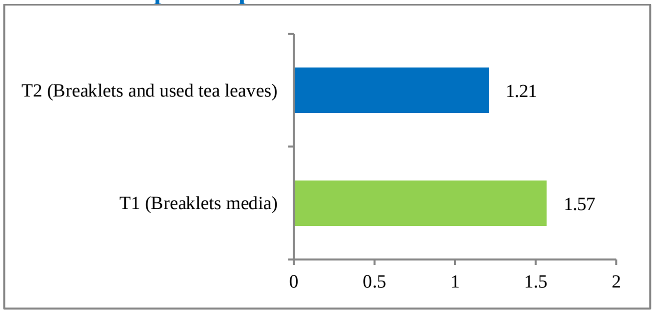

Figure 5. Total water spinach production between the treatments (Treatment-1 and Treatment-2).

The total area employed for water spinach production in the growing medium was 0.78 $\mathbf{m^2}$ (7.79 10-5 hectares). The total production was 1.57 kg for the treatment $\mathbf{T_1}$ and 1.21 kg for the treatment $\mathbf{T_2}$ (Figure 5).

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Fish production

Growth pattern of tilapia

On 5th of June, tilapia culture began, and it was continued for 90 days. On 5th September, the date of experiment's conclusion, all the fish were collected. The fish's original mean length and weight were 15.02±1.26 cm and 64.64±15.50 gm respectively which increased up to 9.23±3.39 cm (61.45%) and 100.52±23.92 gm (155.51%). According to SPSS data, the fish's mean length and weight fluctuated significantly (P=0.01) between sampling days. (Table 3) displays the data gathered on the average length and weight of fish in different sampling dates.

Table 3. Measurements of the fish's length and weight taken on several sample dates.

Date	Length (cm)	Weight (gm)
05.06.21	15.02±1.26	64.64±15.50
20.06.21	16.26±1.22	78.43±14.18
05.07.21	17.56±2.78	85.06±26.47
20.07.21	19.49±2.36	94.82±22.85
05.08.21	20.34±2.67	120.10±41.95
20.08.21	21.10±2.69	138.34±34.75
05.09.21	24.25±4.65	165.16±39.42
Level of significance	**	**

******Mean values are significantly different (p<0.01)

From the above length and weight data of fish it is observed that there was no significant difference of both fish length and weight among two dates 5th June and 20th June. As per analysis from *Statistical Package for Social Science (SPSS)*, it can also be interpreted that there was a significant difference in increase in both fish length and weight between 5th June and 20th September.

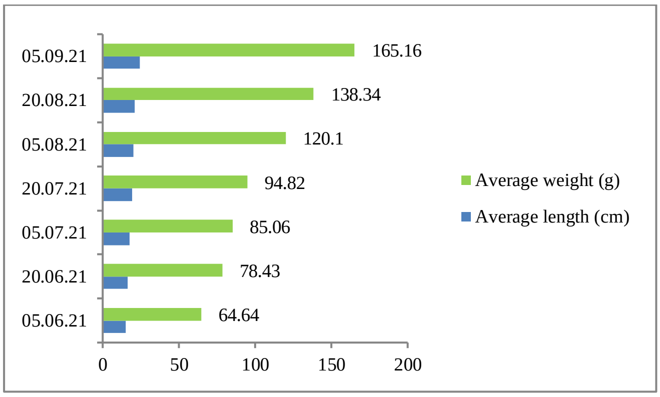

Figure 6. Fish's length and weight measured on several sample dates.

Production

The overall output was 9.91 kg (Table 4). 20% (150 L) of the tank's 750 L were reserved for maintenance. Since no fish losses was found over the whole 60s, the system's fish survival rate can be presumed to be 100%.

Growth performance of tilapia

Table 4 displays the gain in length, gain in weight, percent gain in length and weight, growth rate, food conversion ratio, survival rate as well as fish production for several species.

Table 4. Fish growth performance observed over the study period.

Growth Performances	Value
Mean initial length (cm)	15.02±1.26
Mean initial weight (gm)	64.64±15.50
Mean final length (cm)	24.25±4.65
Mean final weight (gm)	165.16±39.42
Gain in length (cm)	9.23±3.39
Gain in weight (gm)	100.52±23.92
% gain in length	61.45%
% gain in weight	155.51
Growth rate	219.78
Feed conversion ratio (FCR)	1.51
Survival rate (%)	100
Production (kg)	9.91

Conclusion

In light of study, this may be claimed that the aquaponic system can grow fish and vegetables while utilizing less water, no soil, and no fertilizer. For decreasing environmental impact, the technique works well in urban and peri-urban settings. However, over the course of the trial period, both media effectively eliminated waste from fish tanks and cleaned and safe the water for cultivation of fish. The existence of more EC, P, K, S, Na, CO3, and Total-N in influent water than effluent water suggests bacterial activity in plant roots and media, which ultimately results in proper fish waste utilization by water spinach. By recycling the fish waste water from the tank, it can be concluded that the aquaponic system is able to produce an acceptable amount of fish and vegetables.

Acknowledgement

The authors of this manuscript gratefully acknowledge the kind support of the Fisheries and Ocean Sciences. This research was conducted under the funding of the professionals of Khulna Agricultural University (KAU). Such valuable support is also gratefully acknowledged.

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