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Using the Diverse Vegetables as a Filtration plants in Aquaculture Intensive System

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ABSTRACT

Changes to the physico-chemical conditions of treated water affect the biological traits of the aquatic organisms. There are water quality issues in rearing fish using a recirculating aquaculture system. Certain technologies for water treatment to improve its quality are highly energy intensive and expensive to use, thus implying high investment and operating costs. There is needed to look for novel method of water treatment which not only improves water quality and fish growth performance but is also cost effective and energy efficient to face climate change, lack of rain, and consequently fresh water scarcity, especially in the countries most affected in the Middle East. Any improvement by incorporating the mechanical and biological filter in one unit of an aquaponics intensive system is important in order to improve its efficiency and aquaculture yield. By incorporating a plant, namely: strawberry, peppermint, cucumber, and okra as a biological filtration to absorb the nutrient disintegrated additional to the green sponge layer and gravel as a mechanical filtration even for control treatment, aquaculture may become more sustainable in the future. After the acclimation interval, 24 tanks were stocked with 7 fish of an average initial weight of 15.74g. However, treatments were assigned to each container at random to make five treatments. First, this work evaluated the gravel fine mesh was used in the control treatment, strawberry, peppermint, cucumber, and okra, as a biofilter media in an aquaponics system. The results showed a significant effect on common carp average growth performance for cucumber and okra compared to the control treatment. However, a better growth performance for common carp culture in water-exposed cucumber and okra demonstrated significant improvement of FCR. Hence, improve in fish productivity in aquaponics system. There is a significant effect on cell counts and plasma enzyme and biochemistry conditions in strawberry, peppermint, cucumber, and okra biofilter medias. The liver cells and gills of the fishes grown in strawberry, peppermint, cucumber, and okra exhibited a normal sinusoid organisation with no indications of lesions or abnormalities of the hepatocytes. In briefly, the study elucidates the interests of using strawberry, peppermint, cucumber, and okra as a biofilter unit for aquaculture due to improved growth performance of common carp fish.

إستعمال خضروات مختلفة كنباتات ترشيح في نظام الاستزراع المائي المكثف

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الخلاصة

تؤثر التغيرات في الظروف الفيزيائية والكيميائية للماء على السمات البيولوجية للكائنات المائية. هناك مشكلات تتعلق بنوعية المياه في تربية الأسماك باستخدام نظام تربية الأحياء المائية المعاد تدويره. تتطلب بعض تقنيات معالجة المياه لتحسين جودتها استخدامًا كثيفًا للطاقة ومكلفًا، مما يعني ارتفاع تكاليف الاستثمار والتشغيل. هناك حاجة للبحث عن طريقة جديدة لمعالجة المياه لا تعمل على تحسين جودة المياه وأداء نمو الأسماك فحسب، بل تكون أيضًا فعالة من حيث التكلفة وفعالة في استخدام الطاقة لمواجهة تغير المناخ، وقلة الأمطار، وبالتالي ندرة المياه العذبة، خاصة في البلدان الأكثر تأثراً في الشرق الأوسط. إن أي تحسين من خلال دمج المرشح الميكانيكي والبيولوجي في وحدة واحدة من نظام الزراعة المائية المكثف يعد أمرًا مهمًا لتحسين كفاءته وإنتاجية تربية الأحياء المائية. ومن خلال دمج نباتات الفراولة والنعناع والخيار والبامية كمرشح بيولوجي لامتصاص العناصر الغذائية المتحللة بالإضافة إلى طبقة الإسفنج الأخضر والحصى كترشيح ميكانيكي حتى في معاملة السيطرة، قد تصبح تربية الأحياء المائية أكثر استدامة في المستقبل. بعد فترة التأقلم، تم تخزين 24 حوضًا بـ 7 أسماك بمتوسط وزن أولي يبلغ 15.74 غرامًا. ومع ذلك، تم تخصيص المعاملات لكل خزان بشكل عشوائي لإجراء خمس معاملات. أولاً، قام هذا العمل بتقييم استخدام شبكة الحصى الدقيقة في معالجة السيطرة، والفراولة، والنعناع، والخيار، والبامية، كوسيلة للتصفية الحيوية في النظام.الاحيومائي. أظهرت النتائج تأثيراً معنوياً في أداء نمو الكارب الشائع للخيار والبامية مقارنة بمعاملة السيطرة. ومع ذلك، فإن الأداء الأفضل للنمو في استزراع الكارب الشائع في الخيار والبامية المعرضة للمياه أظهر تحسناً ملحوظاً في معدل تحويل العلف. وبالتالي تحسين إنتاجية الأسماك في النظام الأحيومائي.هناك تأثير كبير على عدد الخلايا والأنزيمات للبلازما وظروف الكيمياء الحيوية في وسائط الترشيح الحيوي للفراولة والنعناع والخيار والبامية. أظهرت خلايا الكبد والخياشيم للأسماك المزروعة في الفراولة والنعناع والخيار والبامية تنظيمًا جيبيًا طبيعيًا مع عدم وجود مؤشرات على وجود آفات أو تشوهات في خلايا الكبد. باختصار، توضح الدراسة فوائد استخدام الفراولة والنعناع والخيار والبامية كوحدة ترشيح حيوي لتربية الأحياء المائية بسبب تحسين أداء النمو لأسماك الكارب الشائع.

الكلمات الافتتاحية: نباتات الخضر، الترشيح البيولوجي، خصائص الماء، والكيمياء الحيوية للبلازما

INTRODUCTION

The aquatic animal's production consisted of 82.1 million tonnes of total aquaculture production, and projected to reach 109 million tonnes in 2030 (FAO, 2020). According to UN and UNESCO, aquaculture plays an important role in ensuring an adequate supply of nutritious food to feed the world's increasing population. However, improvement of intensive systems is required since they will have a significant impact on aquaculture's future, and improving unit performance is one of their top priorities (Badiola et al., 2012). Aquaponics is known to be one of the most efficient agriculture production systems by far; however, limited quantitative data are available on the level of efficiency, particularly in comparison to its counterpart, hydroponics.

Effective aquatic creature rearing, including that of crustaceans, fish, and shellfish, depends on good water quality. The maximal growth biomass of cultivated species depends on the maintenance of good water quality. Ammonia content and organic compounds in water are just two of the variables that might cause indicators to send either positive or negative signals, according to Carbajal-Hernández et al. (2013) water conditioning in intense fish breeding should be the removal of prejudicial fish metabolic products, such as urea, ammonia and dissolved and suspended organic matter (Hassan et al., 2021; Hassan et al., 2022). Unconsumed food waste accumulates in the water over time and must be removed to maintain the water's quality (Carbajal-Hernandez et al., 2013). Maintaining an environment for the product being produced requires adequate, ongoing filtering. Poor water quality will lead to decreased productivity, mortality, and growth. The water is filtered to remove extra nutrients, metabolic waste, and particulates (Hassan et al., 2021; Zaidan et. al., 2023).

By absorbing oxygen and oxidizing the organic materials to produce carbon dioxide, ammonia, and sludge. The key concerns of the cultivator are the treatment of ammonia, nitrite, and suspended particles (FAO, 2015). In a closed system, the filtration subsystem can be separated into mechanical and biological components, with the latter removing unwanted or surplus nutrients, particularly NH_3-N and nitrites (Hutchinson et al, 2004). Recent improvements made by intensive systems are the ones that promote environmental sustainability (Ray & Lotz, 2017; Hassan et al., 2018a, 2018b; Xiao et al., 2018). In order to ensure that the recirculated water has the required characteristics for fish breeding, proper environmental conditions must be created. According to Dalsgaard et al. (2013), one of the biggest obstacles to a sustainable intensive system is the high cost, which calls for large-scale intense production with lower the investment and operating expenses (Van Rijn et al., 2006). Water treatment methods that guarantee an improvement in quality also guarantee a high energy and financial investment and operational cost, the requirement to search for a novel aquaponics system by incorporating mechanical and biological filtration units, then test the best vegetable filtration plants. Due to environmental factors impacting fishes physical condition, growth performance, and yield, the management of water quality conditions is important, especially if the fish are to be produced in aquaculture systems. Aquaponics enhances aquaculture sustainability and productivity and finding a suitable plant for biological filtration is necessary to filter water from harmful nitrogen compounds (Sikora et al., 2018). Understanding the details of transmission in aquaponics production systems is vital for managing the aquaculture, the main limitation of rapid media filtration is increased maintenance time and cost, compared to slow filtration. However, rapid media filters were examined with much less frequency in the literature on production systems, highlighting a research gap (Mori and Smith, 2019). There is no research concerning about the incorporating aquaponics comparing between strawberry, peppermint, cucumber, okra effect on water characteristics, common carp growth performance, liver and gill histopathology, biochemistry, and plasma enzymes.

MATERIALS AND METHODS

Aquaponics's system with different filtration plants

Combining a different biological filter and vegetable plant in an intense system for water treatment. To examine the effects of strawberry, peppermint, cucumber, and okra (Figs. 1 and 2) on common carp growth performance, water was first pre-treated in a mechanical filter unit and then channelled to a more intensive treatment using a biological filtration. The length of the pipes that carried the water to each tank after it had passed through the filtration was 110 cm between the mechanical-biological filtration tank and the first grow-out tank, 110 cm between the first and second grow-out tank, and 110 cm between the second and third grow-out tank. Each treatment was made to allow water to flow past the biological filtration treatment in a pipe. The Department of Animal Production, College of Agriculture, University of Tikrit, Salah Al-deen, Iraq, was the site of this experiment. As seen in Fig. 2, there were a total of four treatments, each of which had three replicas of 100L tanks in a different aquaponics system. The water was then pumped back to the tanks of the same biological media via a centrifugal pump and the water was exchanged 15 times daily. The system was designed to allow each aquaponics system to flow to 300L tank per treatment to ensure that each treatment is treated in a separate tank to avoid mixing and preserve the various biological media effects of each treatment.

Four tanks, each holding 100 L, serve as a filtering unit, although. In spite of this, the 100L contained strawberry, peppermint, cucumber, and okra as a biological filter above a gravel fine mesh (50 kg), which aids in the biological filtering. As a biological filtration were connected to the treatment tanks in such a way that the biological treated the water before returning to the rearing tanks, no other biological filtration media than 50 kg of gravel fine mesh were utilized in the control treatment aquaponics system. Every two weeks, a partial water exchange was carried out to maintain water quality (20%) and to wash the mechanical filters, although wastewater from all tanks was collected via a single line for the planned output.

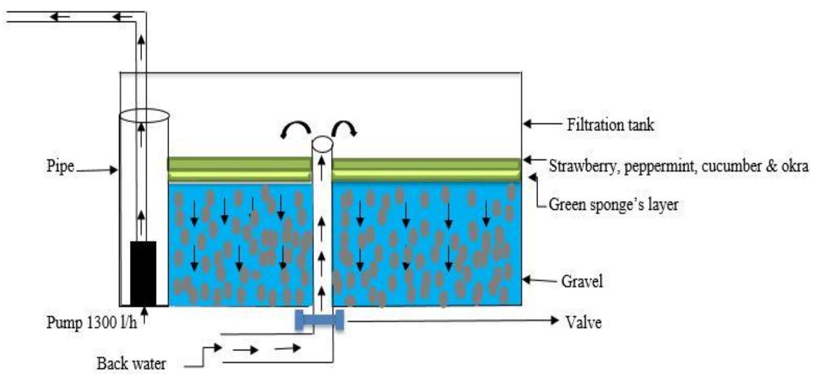

Figure 1: Longitudinal of the mechanical, biological filtration tanks of aquaponics system.

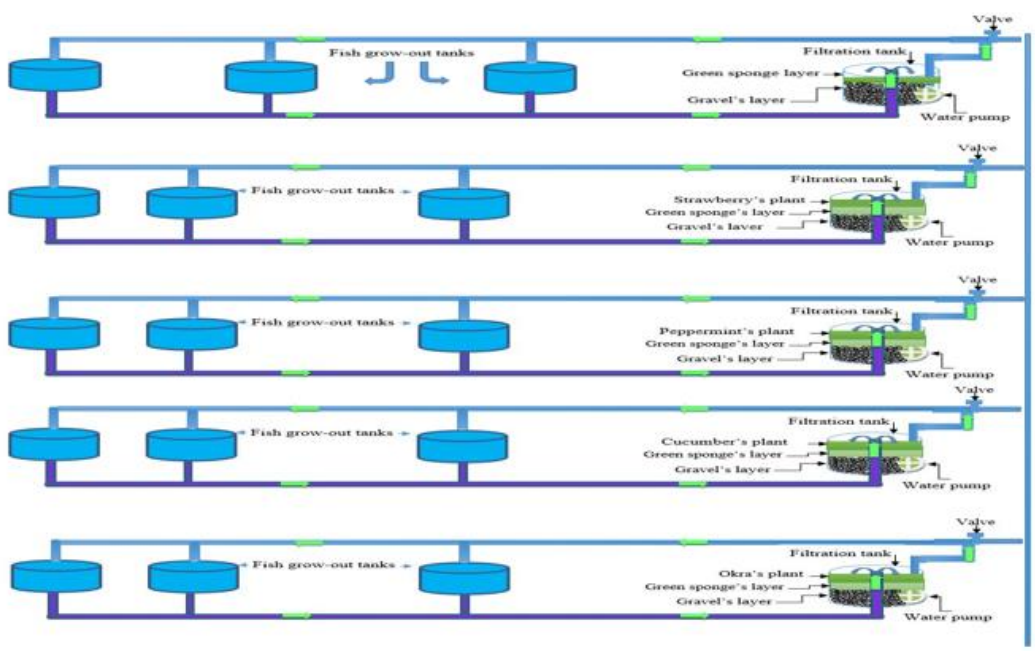

Figure 2: The grow-out, biological filtration plants treatment tanks of aquaponics in the experimental.

Experimental of fish's source and experimental design

Common carp juveniles were acquired from Salah Al-deen private hatchery and acclimated for two weeks in a 5,00L plastic tank. After the acclimation period, 24 tanks were stocked with seven fish of an average initial weight of 15.74g and average initial length of 9.56cm. However, treatments were designed to each container at random to make four treatments. The fish were fed a commercial pellet 4mm (30% protein, 3% lipid (Arbel fed) twice daily (09:30 and 15:00) 3% of body weight to satiation. Daily feed intake was recorded while temperature, dissolved oxygen (DO), pH, total dissolved solids (TDS), salinity, Nitrogen dioxide, AL (ppm), CL (ppm) and ammonia-N (mg l^{-1}) measured weekly from each replicate by using water quality meter.

At the end of the experiment, about 100ppm of clove oil was used to euthanize the fish in each tank and measured for final weight and length. The specific growth and feed conversion ratio (FCR) were calculated using the following equations:

SGR for weight = specific growth rates (% day^{-1}) = $[(\ln W_1 - \ln W_0) / T] \times 100$; where W_1 = final weight, W_0 = initial weight and T = time in days

SGR for length = specific growth rates (% day^{-1}) = $[(\ln L_1 - \ln L_0) / T] \times 100$; where L_1 = final length, L_0 = initial length and T = time in days

The feed conversion ratio (FCR) was determined using the following equation:

FCR = total dry weight of diet fed (g) / wet weight gain (g)

From the six fish, the viscera were removed and weighed, and then the liver was separated to be removed and weighed to determine the hepatosomatic index (HSI) and viscerasomatic index (VSI), respectively, using the following equations:

VSI = [viscera weight (g) / body weight of fish (g)] × 100

HSI = [liver weight (g) / body weight of fish (g)] × 100

The condition factor is expressed using the equation, K = 100W/ Lb.

The survival rate is calculated using the following equation.

SR (%) = $(N_2/N_1) \times 100$

where SR is the survival rate, N_2 is the final total number of fish alive, and N_1 is the initial total number of fish.

Plasma biochemistry

Blood was collected using 2.5 ml syringes from the caudal vein of two fish in each replicate tank. The blood sample was centrifuged at 360 × g for 15 min and the plasma was taken away and stored at -20 °C until analysis of total protein, mg/ dl, creatinine mg/ dl, albumin g/ dl, urea mg mg/ dl, AST/GOT lu/ml and ALT/GPT lu/ml is carried out.

Preparation and dyeing liver and gill sections with routine stain (Hematoxylin and Eosin)

Set all the liver and gills in formalin 10% for 18-24 hours, then transferred to 70% ethanol for three hours. The dehydration process was using increasing concentrations of ethanol and alcohol are as follows: 80%, 90%, 95%, 100%, 100% for a period of 30 minutes each, and clearation samples using a mixture of absolute ethanol and xylene 1:1, samples were then transferred to two changes of xylene for a quarter of an hour each .The infiltration process and imbedding in a mixture of xylene, paraffin wax and molten candidate (degree melting 58-60) for half an hour and then transferred to three changes of pure paraffin and kept one hour in each of them, then embedded in paraffin using pure templates, steel plated glycerine then left to harden at room temperature. Accomplished cutting samples using a rotary microtome device thickness 7-8 micrometers, and carried the sections on glass slides clean and dried, placing them horizontally in an incubator temperature of 40 Celsius. Painted all sections skin with the two dyes hematoxylin and eosin and depending on the steps of the following: Put the slides in two changes of xylene for 5 minutes each in order to remove paraffin wax, and then passed to the concentrations of regressive of ethanol and as follows: 100%, 95%, 90%,80%, 70% for 5 minutes per stage. Then colored dye hematoxylin for 8 minutes and then washed with running tap water for 15 minutes and characterized the acidified alcohol if necessary. Then put the slides in distilled water for 5 minutes and put the slides in 70% ethanol and colored dye eosin for 1-2 minutes, then passed the slides with concentrations upward of ethanol as such 70%, 80%, 90%, 95%, 100%, 100% for a period of at least 5 minutes for each stage. Then clearing the sections were transported with three changes of xylene for 5 minutes each. Finally carried the histological sections with adhesive and covered with cover slide to be ready for examination under the microscope (Bancroft and Stevens,1982).

Statistical analysis

One-way ANOVA was used to analyse the data at ("P"< 0.05) and Duncan's multiple range test was used to distinguish significant differences between the treatments. All data were expressed as means ± standard deviation (SD) (n=3) and analysed using Statistical Analysis Software (SAS) Version 9.

RESULTS AND DISCUSSION

Water Characteristics

There is a significant difference among the control and other filtration vegetable treatments (strawberry, peppermint, cucumber, and okra) in water AL (ppm), CL (ppm), nitrogen dioxide, total dissolved solids (mg L^{-1}), salinity (ppt), pH, and dissolved oxygen (mg l^{-1}) when exposure to the strawberry, peppermint, cucumber and okra compare with control treatment. The results showed the lowest significant decrease for AL (ppm), CL (ppm), Nitrogen dioxide, TDS (mg L^{-1}) and pH respectively as illustrated in Table 1.

Table 1: The mean (±SD) of various water quality factors over two months of rearing common carp and different filtration vegetables in a modified aquaponics system.

Water quality	Control	Strawberry	Peppermint	Cucumber	Okra
Temperature (°C)	26.17±0.15 ^{a}	25.5±1.5 ^{a}	25.25±1.25 ^{a}	25.5±1.5 ^{a}	25.25±1.25 ^{a}
AL (ppm)	156±2.64 ^{a}	148.67±0.57 ^{bc}	144.67±2.51 ^{c}	152.33±2.08 ^{ab}	136.33±6.02 ^{d}
CL (ppm)	0.0767±0.04 ^{a}	0.043±0.01 ^{abc}	0.045±0.03 ^{bc}	0.047±0.01 ^{abc}	0.025±0.01 ^{c}
Nitrogen dioxide	0.267±0.04 ^{a}	0.203±0.02 ^{bc}	0.133±0.03 ^{d}	0.153±0.03 ^{d}	0.16±0.02 ^{dc}
Ammonia-N (ppm)	0.01± 0 ^{c}	0.01± 0 ^{c}	0.01± 0 ^{c}	0.013± 0.01^{c}	0.01±0 ^{c}
TDS (mg L^{-1})	347.3± 15.88 ^{abcd}	279.3± 1.52 ^{cd}	559± 21.16 ^{a}	213± 3.46 ^{cd}	99.84± 167.3 ^{d}
Salinity (ppt)	0.367± 0.01 ^{c}	0.283± 0.01 ^{c}	0.603± 0.01 ^{c}	0.21± 0.01^{g}	0.323± 0.01^{e}
pH	7.627± 0.03 ^{a}	7.263± 0.04 ^{c}	7.4± 0.2 ^{abc}	7.467± 0.23 ^{abc}	7.2± 0.2 ^{c}
DO (mg L^{-1})	8.47± 0.15^{abc}	8.37± 0.12^{abc}	8.67± 0.21^{a}	8.6± 0.2^{ab}	8.17± 0.15^{cd}

Means are± SD and various superscripted letters in each row reference significant differences ($p < 0.05$).

Survival and growth performance

The Common carp growth performance and feeding efficiencies of exposed to gravel, gravel+ Strawberry, gravel+ Peppermint, gravel+ Cucumber, and gravel+Okra as illustrated in Table 2. The final body weights noted 50.82 gm, 53.67 gm, 54.43 gm, 52.19 gm, and 52.29 gm for the control, strawberry, peppermint, cucumber and okra respectively, the highest growth biomass was in Peppermint compared with other treatments. It can be seen that a significant increase and better than the control in fish final length 16 cm and final body depth 4.69 cm, when water has been exposed to peppermint. The highest significant effect was recorded for specific growth rate (SGR) to fish weight and specific growth rate (SGR) to fish length (1.38 and 0.29) in the okra compared with control treatments which were 0.32 and 0.15 respectively. The best significant increase in weight gain observed 377 gm in cucumber and okra compared with control 184.27 gm and all other treatments. Meanwhile, there is no significant effect for fish hepatosomatic index and viscerasomatic index and spleen somatic index under control, strawberry, peppermint, cucumber, and okra filtration treatments. Moreover, a significant lower effect in the Feed conversion ratio (FCR) between control 3.34, strawberry 2.24, peppermint 2.09, cucumber 1.6, and okra 1.59 respectively. The Protein efficiency ratio (PER) of Strawberry 1.38 showed exhibited significant difference compared with Peppermint 1.48, Cucumber 1.97, Okra 1.97, and control 0.89, respectively. Furthermore, the survival rate of common carp was affected by the different treatments.

Table 2: Mean (±SD) growth performance and feeding efficiency of fish and different filtration vegetables in modified aquaponics system.

Parameters	Treatments				
	Control	**Strawberry**	**Peppermint**	**Cucumber**	**Okra**
Initial weight (g)	42.05±2.93[a]	40.71±2.71 [a]	40.62±1.41 [a]	41.38±3.66 [a]	40.48±3.76 [a]
Final weight (g)	50.82±1.99 [a]	53.67±7.8 [a]	54.43±5.11 [a]	52.19±1.43 [a]	52.29±5.94 [a]
Initial length (cm)	13.97±0.7 [a]	14.19±0.68 [a]	14.1±0.74 [a]	13.74±1.02 [a]	13.24±0.42 [a]
Final length (cm)	15.27±0.56 [a]	15.92±1.09 [a]	16±0.41 [a]	15.85±0.4 [a]	15.73±0.53 [a]
Final body depth (cm)	4.59 ± 0.12	4.42± 4.42	4.69 ± 0.18	4.51 ± 0.08	4.55 ± 0.24
SGR length	0.15 ± 0.14 [a]	0.19 ± 0.11 [a]	0.21 ± 0.12 [a]	0.24 ± 0.11 [a]	0.29 ± 0.11 [a]
SGR weight	0.32 ± 0.07 [b]	0.45 ± 0.15 [b]	0.45 ± 0.20 [b]	0.71± 0.14[b]	1.38 ± 0.36 [a]
Gain Weight (GW)	184.27±9.89[b]	272±39.31[ab]	274±30.86[ab]	377±16.04[a]	377±21.73[a]
Condition factor	1.43±0.10 [a]	1.33±0.06 [a]	1.32±0.05 [a]	1.31±0.07 [a]	1.30±0.05 [a]
Hepatosomatic index	2.15 ± 0.33 [a]	1.85±0.54 [a]	2.52±0.21 [a]	2.13±0.46 [a]	2.11±0.47 [a]
Viscerasomatic index	14.31 ± 2.53 [a]	14.13±0.67 [a]	15.62±0.78 [a]	12.84±1.25 [ab]	14.00±2.27 [a]
Spleen somatic index	0.16±0.00 [a]	0.13±0.02 [a]	0.17±0.02 [a]	0.12±0.03 [a]	0.12±0.06 [a]
Feed intake	617±13.2 [a]	608±9.01 [a]	575±4.16 [a]	597±10.44 [a]	598±2.1 [a]
Feed conversion ratio	3.34±0.83 [a]	2.24±0.79 [ab]	2.09±1.02 [ab]	1.6±0.14[b]	1.59±0.19[b]
Survival%	66.66 ± 21.82 [a]	95.23 ± 32.9 [a]	90.47 ± 8.2 [a]	95.24 ± 8.2 [a]	90.48 ± 8.2 [a]
PER	0.89 ± 0.13[b]	1.38 ± 0.53[ab]	1.48 ± 0.77[ab]	1.97± 0.17 [a]	1.97± 0.23 [a]

Means are± SD and various superscripted letters in each row reference significant differences ($p < 0.05$).

Liver and kidney plasma biochemistry parameters

The differential liver and kidney plasma biochemistry of fish exposed to various vegetables as filtration plant as illustrated in Table 3. The Urea mg/dl, creatinine mg/dl, total protein mg/dl, AST/GOT lU/ml in fish exposed to strawberry, peppermint, cucumber and okra were significantly higher than in fish exposed to control treatment. The Albumin g/dl and GPT were lower in the cucumber and okra treatments compared to the control treatment. Meanwhile, the albumin g/dl was significantly upper in strawberry than control and then equals in the peppermint treatment.

Table 3: Mean (±SD) kidney plasma biochemistry in common carp different vegetables as filtration plant in modified aquaponics system.

Treatments	Control	Strawberry	Peppermint	Cucumber	Okra
Plasma enzyme and biochemistry					
Urea mg/dl	17.27±0.22^{d}	18.64± 0.75^{cd}	25.11± 1.78^{b}	20.79± 2.19^{c}	19.04± 0.95^{cd}
Creatinine mg/dl	0.80± 0.16^{cd}	1.01± 0.24^{abcd}	1.21± 0.19^{ab}	1.13± 0.25^{abc}	0.903± 0.07^{bcd}
Total protein mg/dl	1.27± 0.28^{d}	2.67± 0.06^{a}	1.61± 0.16^{bc}	2.52± 0.07^{a}	1.57± 0.07^{c}
Albumin g/dl	1.18± 0.08^{bc}	1.7± 0.04^{a}	1.197± 0.30^{b}	0.86± 0.09^{c}	0.332± 0.05^{d}
AST/GOT lU/Ml	6.06± 0.30^{h}	52.08± 1.94^{a}	32.96± 2.05^{d}	15.71± 0.27^{f}	41.56± 0.85^{b}
ALT/GPT lU/Ml	4.06± 0.80^{c}	10.88± 1.11^{a}	11.74± 1.08^{a}	3.03± 0.25^{c}	4.28± 0.10^{c}

Means are± SD and various superscripted letters in each row reference significant differences ($p < 0.05$).

Liver Histopathology

The fish liver tissues in the control, strawberry, peppermint, cucumber, and okra treatments illustrated in Figure 3, a, b, c, d, and e. liver tissues have hepatocytes (HP), kupffer cells(KC), sinusoid(S), piknosis(P), fibrosis(F) cell in the control treatment. Fish liver tissues exposed to strawberry showed increased of hepatocytes (HP), Kupffer cells(KC), cells in division stage (DC), thick of the plasma membrane. The results showed Kupffer cells(KC), cells in division stage (DC), foamy cells (FC) of the tissues of liver tissues in the peppermint treatment. Increased of kupffer cells(KC), cells in division stage (DC), and foamy cells(P). Fish liver tissue which exposed to cucumber and fish liver tissues which exposed to okra.

Gills Histopathology

For fish gills exposed to a control, strawberry, peppermint, cucumber, and okra, one gill showed in Figure 4 a, b, c, d, and e. fish gills showed normal primary lamellae(PL), secondary lamellae,(SL), epithelial cells (EpC), mucous cells(MC) in the control treatment. on the other side, fish gill noted normal primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) with strawberry, but in the fish gills in peppermint showed primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) adipose tissues under the cartilage region (Ad t). Finally, normal primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) were noted within fish gills in the okra.

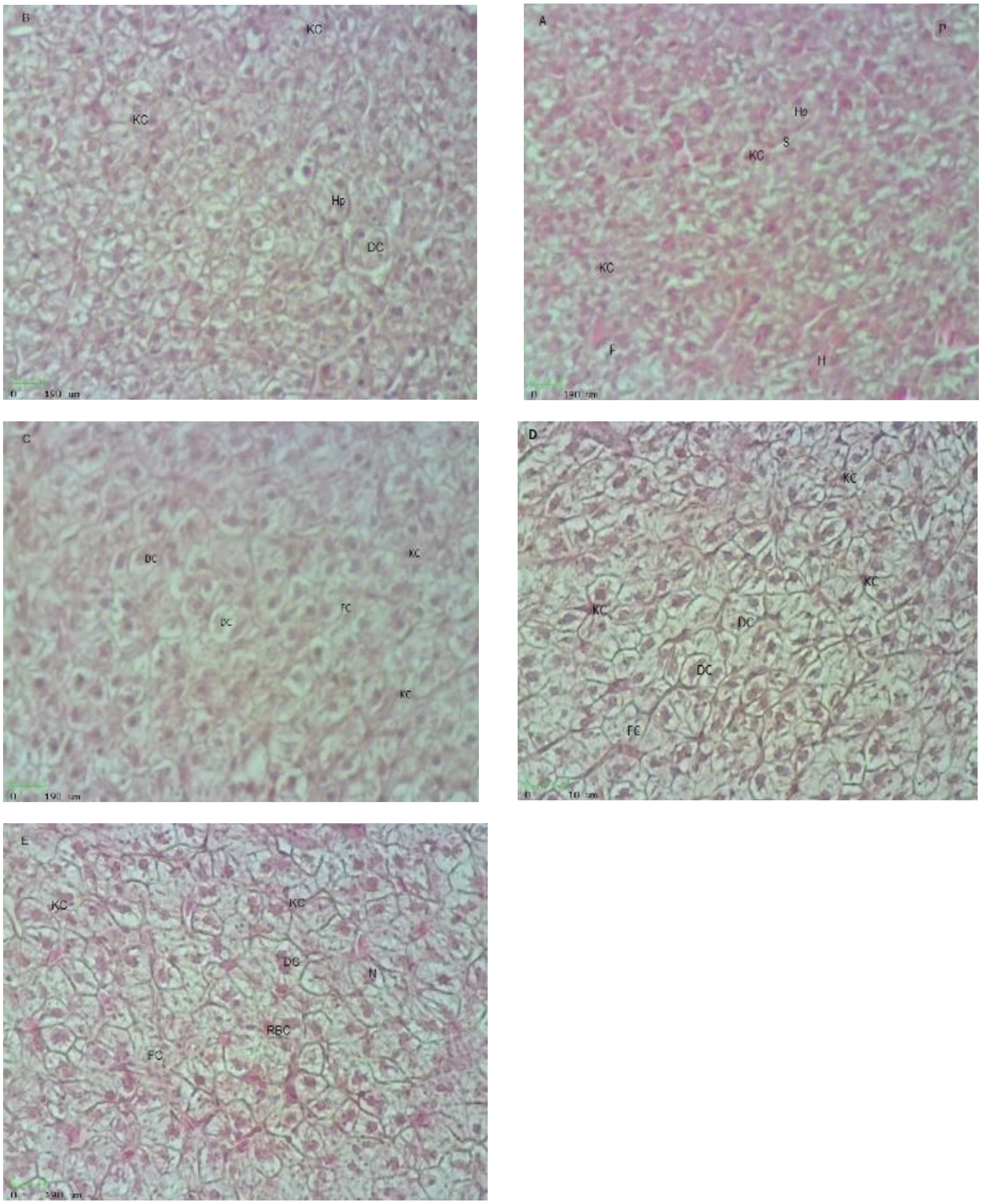

Figure 3: The liver tissues in fish show (A):(control) hepatocytes, (HP), kupffer cells, (KC), sinusoid, (S), piknosis, (P), fibrosis(F). (B): given(strawberry) hepatocytes (HP), kupffer cells(KC), cell in division stage (DC). (C) given(peppermint) kupffer cells(KC), cell in division stage (DC), foamy cells (FC). (D): given (cucumber) kupffer cells(KC), cell in division stage (DC), and foamy cells(P). (E): given(okra) kupffer cells(KC), cells in different division stages (DC) necrosis(N), foamy cells(FC), red blood cells (RBC). 400X (H&E).

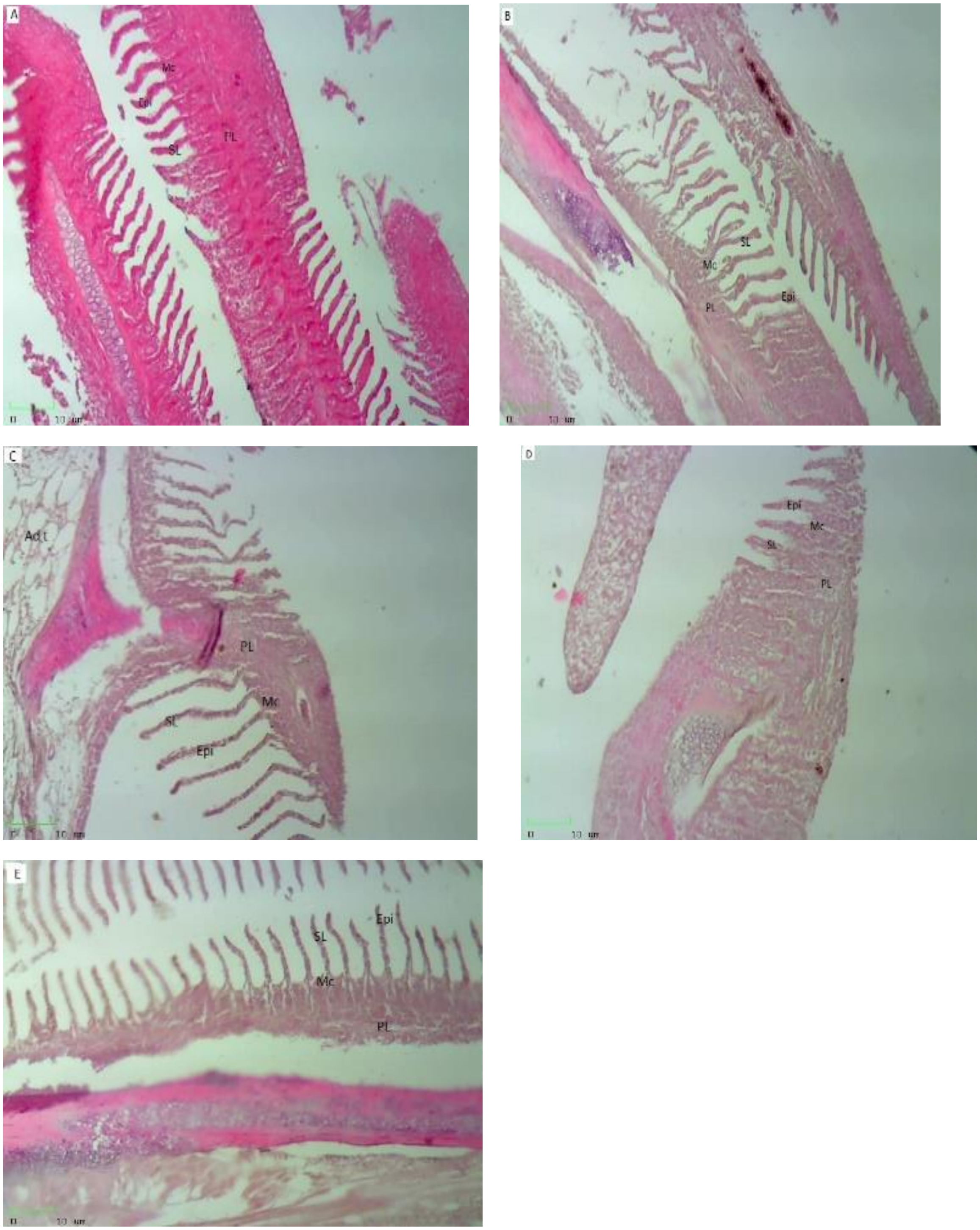

Figure 4: The gills of fish showed (A):(control) normal primary lamellae(PL), secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) (B): given(strawberry) normal primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) (C) given(peppermint) primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) adipose tissues under the cartilage region (Ad t). (D): given (cucumber), primary lamellae(PL), secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC). (E): given(okra), normal primary lamellae(PL), thin secondary lamellae(SL), epithelial cells (EpC), mucous cells(MC) 100X (H&E).

The growth, survival rate, and biomass performance of aquatic organisms are all impacted by water quality. Specific indicators are used to determine water quality, so it should match the needs of the fish. There are several water characteristics that affect on fish growth, such as nitrites, nitrogen, pH, and nitrates, where any change in these variables could have a fundamental impact on the performance of fish growth. Control of these factors is essential for the growth of aquaculture production, and the best water quality is essential for the best fish growth since it reduces stress to fish (Carbajal-Hernandez et al., 2013 and Lopez-Luna, 2013). The water filtering decisions have a big impact on the reusability and short- and long-term properties (Fleckenstein et al., 2020). According to recent research, biofilters are often constructed using natural media to provide a large surface area (Losordo et al., 1998; FAO, 2015). With low water velocities in the sedimentation zone, the installation of an annular settler composed of concentric cylinders in an intensive tank provided for the fish's ideal growing conditions and developed the natural removal of solids (Miguel et al., 2021). Aubergine, tomato, and cucumber cultures were established in various aquaponics system capacities for the elimination of nitrogen and suspended particles were predetermined for fish farming and nutrient removal rates calculated to assess the recycle nutrients for fish. Rana et al., (2011) cultivated tomato plants on the floating bed of pulp-free coconut fiber over four different concentrations of wastewater (25%, 50%, 75%, and 100%) and groundwater as control. One of the studies showed removal 75% of NO_3-N in all treatments and ammonium-Nconcentration was subsided below the toxic level in all treatments by fruit harvest were achieved during tomato culture: fruit production removed 0.52, 0.11 and 0.8 g d1 for N, P and K in hydroponic and 0.43, 0.07 and 0.4 g for N, P and K in aquaponics (Graber and Junge, 2009). According to Suhr and Pedersen (2010), environmental and operational constraints of such stream conveyance and discharge systems have a significant impact on the ammonia nitrogen expulsion rates in biofilters. There is a significant decreasing in the water characteristics in strawberry, peppermint, cucumber, and okra compared control treatment in the current study. Digestion and other physiological cycles are affected by pH, throughout the whole experiment, pH was within acceptable range according to water quality criteria for distribution framework. Utilizing phytoremediated aquaculture wastewater for production of Gotukola (*Centellaasiatica (L.),* a leafy vegetable as well as a traditional medicinal plant; and koi carp. The highest removal of nitrite N was 92.34%, nitrateN 70.55%, and ammonia 71.36% (Nuwansi et al., 2019). Of five locally available media were evaluated in comparison to the commercial media (plastic), only coconut shells could compete with the commercial plastic biofilter by demonstrating volumetric total ammonia nitrogen and volumetric nitrite conversion rates which were not significantly different (Munubi, et. al., 2022).

Excess non-ionic ammonia should be removed in order to maintain the water quality climate because the medium, which is often a flexible packing and the center of a biofilter, is essential to its operation (Xiao et al., 2018). Additionally, the innovation's all-out total ammonia nitrogen expulsion rate ranged from 80 to 95 percent, and its nitrite N evacuation rate exceeded 80 percent (Peirong and Wei, 2011). The biological characteristics of the aquaculture organisms appear to be impacted by the water quality.
Therefore, the result of the correlation or interactions between water characteristics with growth parameters for Common carp fish showed significant effects at ($P \leq 0.05$) and ($P \leq 0.01$) level in two aquatic plants were grown Water thyme (*Hydrilla Verticillata*), Torpedo grass (*Panicum Repens*) of an intensive aquatic system(Faisal et al.,2023a).

This is especially clear in the biomass of common carp, the improvement in development growth performance using available vegetable plants comparing the control treatment are used to create biomass at an optimum growth rate, exposure to cucumber, and okra significantly increased feed conversion ratio comparison to the control. The results indicated that although fish survival, growth, and feeding efficiency were similar between the RAS and aquaponics system, on other hand, the Nitrate-N levels were substantially lower in the aquaponics, when lemongrass and spring onion were cultured with or without gravel (Fischer et. al., 2021). The results showed a significant effect of three aquatic plants (lentils, Azolla, Ceratophylom) on dissolved oxygen DO (mg / liter), pH, total dissolved salts (TDS), nitrate NO3, nitrite NO2, and ammonia, then reflect that on the weight gain (G.W), relative growth (RGR), specific growth of fish (SGR), and feed conversion efficiency (FCR) of Common Carp Growth Performance in aquaculture intensive system(Faisal et al.,2023b).

Three different biological systems (fish, plants, and nitrifying bacteria) with different requirements are merged to develop double recirculating aquaponic system for a high productivity. The results show that double recirculating aquaponic system contributes to lower the operating costs of plant production and to relief the environment, which is mainly based on the reuse of fish wastewater and associated reduced quantity of nutrient emissions (Suhl et. al.,2016). One of the studies showed a twofold better yield of tomato in combination with *O. niloticus* reared in a coupled gravel bed aquaponic unit compared with the use of *C. carpio*. Harvest of less demanding cucumber showed slightly higher total values in combination with *C. carpio*. Growth of lettuce was zero as a result of interspecific competition (light, space) in the hydroponic units (Knaus & Palm, 2017). Cherry, tomato, basil, and lettuce were cultured in recirculating tilapia, N and P mass balances were developed by using N and P concentrations in fish feed, solid waste, wastewater, fish biomass, and plant biomass for aquaponic systems and plant biomass for hydroponic systems, which should be combined with proper crop choice, operation conditions, and management practices to further improve the efficiency of the systems (Yang and Kim, 2020).

Fish FCR can be affected by a variety of factors, some of which include feed palatability, water quality, stress, and calorie intake (Houlihan et al., 2001). Due to the last point, less energy and food would be required to meet the needs of the fish if the supplement and energy usage were improved by using vegetable plants as a medium to absorbent by-products of nutrition. Blood plasma indicators like total protein, creatinine, and urea were significantly impacted by the determination of water conditions. Growth rates and blood indices, such as total protein and alkaline phosphatase activity, can be used to physiological stress of fishes (Montero et al, 1999). Fish blood components are indirectly affected by physiological state and water quality (Hassan et al., 2018a).

There is evidence that incorporating and comparing strawberry, peppermint, cucumber, and okra as a biological filtration effect to plasma enzymes and biochemistry, in turn, influence the plasma urea mg/dl, creatinine mg/dl, total protein mg/dl, albumin g/dl AST/GOT lU/Ml and ALT/GPT lU/Ml. Diverse studies were used of fish plasma as an indicator of fish health (Kumar et al., 2010; Liu et al., 2014; Hassan et al., 2019). The liver cells and gills of the fishes grown in the treatment and those of strawberry, peppermint, cucumber, and okra exhibited a normal sinusoid organisation with no indications of lesions or abnormalities of the hepatocytes. Ammonia levels more than 0.10 mgL-1 will typically cause gill damage, destruction of mucous supplying membranes, and effects such as impaired feed conversion, helpless feed transformation, uncomfortable osmoregulatory function, and kidney failure (Bhatnagar and Devi, 2013).

CONCLUSIONS

The improvement in the aquaponics intensive system by incorporating the mechanical and biological filter in one unit is important in order to improve its efficiency and aquaculture yield. This study is a step towards enhancing the aquaculture production by comparing the strawberry, peppermint, cucumber, and okra and green sponge layer, gravel as a mechanical and biological filtration and then absorption the solid and liquid waste in this system. The proposed technological development is the incorporation and comparing of different vegetable filtration plants that could reflect on water properties and then fish growth biomass, this design has never been introduced or tested for aquaculture systems. Indeed, the growth performance utilisation is improved by the using of strawberry, peppermint, cucumber, and okra, a better feed conversion ratio in cucumber and okra, would be desirable to satisfy the fish's needs. The liver cells and gills of the fishes grown in a strawberry, peppermint, cucumber, and okra exhibited a normal sinusoid organisation with no indications of lesions or abnormalities of the hepatocytes. Clearly, more researches are required to elucidate the exact reason (s), but a significant increase in feed conversion ratio improves the cost of producing common carp compared with control. Hence, this simple and retrofitable intensive system is a promising solution to develop fish farm production in intensive culture systems. This study, performed under half-uncovered conditions therefore, concludes that cucumber and okra have the potential to be used as biological filters and better than other treatments for aquatic organism's production in a modified aquaponics system.

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DECLARATIONS

ETHICAL APPROVAL

The use of common carp in our study adheres to the animal use protocol (AUP) and is approved by the Animal Care and Use committee (ACUC).

COMPETING INTERESTS

The authors declare they have no financial interests.

AUTHORS' CONTRIBUTIONS

Sadam Mohamad Hassan Supervision-Writing. Nuha Hameed Albassam Methodology (Water quality). Najlaa Salah Madlul Software (Statistical analysis). Muna Salah Rashid Methodology (Liver and Gills Histopathology). Ahmed Ramadhan Muhaimeed Resources (facilities). Muhammad Aliyu Sulaiman Review & Editing (Languge proofreading).

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DATA AVAILABILITY STATEMENT

The data supporting the findings of this study is available from the corresponding author upon reasonable request.

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