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Impact of partial replacement of well water with treated sewage water on water quality and physiological response in common carp Cyprinus carpio L.

Shireen Othman Ahmad[1] **Ayub Younis Anwar[2]**

[1] *Department of Fish Resources & Aquatic Animals, College of Agricultural Engineering Sciences Salahaddin University- Erbil, Kurdistan Region-IRAQ.*
[2] *Department of Fish Resources & Aquatic Animals, College of Agricultural Engineering Sciences, Salahaddin University-Erbil, Kurdistan Region-IRAQ.*
.*Corresponding Author: sheernosman81@gmail.com.

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ABSTRACT

The study examines the effects of partially replacing well water with treated sewage water on water quality, growth performance, carcass composition, and blood parameters in common carp. Common carp (mean weight = 104.16 ± 0.83 g) were reared in 12 experimental tanks, which well water replaced by 0%, 25%, 50%, and 75% of treated sewage water. A result showed that final body weight (FBW) was significantly reduced in fish reared in tanks with 50% well water replaced with treated sewage water. No significant difference was found among treatments in the values of weight gain (WG), specific growth rate (SGR), and feed conversion ratio (FCR). The lowest level of survival was (83.33±3.33) recorded in fish reared in water with 75% well water replaced with sewage-treated water, which was significantly lower than the control and other groups of fish. Substituting well water with sewage-treated water resulted in higher levels of BOD, EC, NO_3^- , COD, Mg, Cl, Na^+ , K^+ , TDS, TSS and salinity. However, ammonia levels decreased significantly as the replacement level increased. Biochemical tests in the serum showed significant changes with the substitution of well water with sewage-treated water. The levels of AST, ALT, ALP, cholesterol, TG, HDL, VLDL, urea, uric acid, total protein, albumin, lipase, amylase, and glucose increased with the substitution of 75% of well water with sewage-treated water. The study concluded that substituting well water with sewage-treated water had a significant effect on water quality and serum biochemical testing, but no effect on growth performance and carcass composition.

***Keywords*:** Sewage water, common carp, growth performance, water quality, biochemical parameters.

Introduction

Food security and nutrition are still at risk owing to climate extremes, degradation of the environment, economic shocks, the high cost and limited accessibility of nutrient-dense foods [1]. The aquaculture sector is essential for addressing the world's shortage of food. By 2028, the proportion of fish produced for human consumption that comes from aquaculture is expected to rise from 52% (the average for the years 2016–2018) to 58% [2].

Freshwater has long been recognized as one of the most valuable renewable resources needed to sustain human civilization, but its supply is constantly diminishing due to factors such as population growth, waste, pollution and climate change [3]. Because aquaculture has a restricted supply of freshwater, recycling wastewater, including treated household sewage, has become essential for aquaculture [4]. Wastewater, commonly referred to as sewage, is essentially the water supply of a community that has been polluted through various applications [5].

Wastewater consists of a mixture of groundwater, surface water, and stormwater, along with the liquid utilized to carry away waste extracted from residential, commercial, and industrial establishments [6]. A wide range of products used in modern society, including soaps, synthetic detergents, oils, phenyls, petroleum products, industrial wastes, agricultural chemicals, and inorganic and organic compounds, are found in high concentrations in raw sewage. Sewage contains high densities of biotic organisms, including harmful bacteria, viruses, worms, and protozoa, which have an impact on the natural water environment [7]. Treated sewage water is typically only used in aquaculture when it is judged suitable for reuse. It is avoided to apply raw sewage directly. In order to lower the pollutants and microbiological load, raw sewage was cleaned before being used in culture ponds [4]. The development of fish farms and related activities has been demonstrated to benefit from recycling sewage through efficient treatment and application techniques [8, 9, 10, 11, 12, 13, 14, 15, 16]. Fish reared in treated sewage water have been proven safe for human consumption [17].

This study aimed to evaluate the effects of partially substituting well water by treated sewage water on growth rate, carcass composition, blood parameters, and water quality in common carp “*Cyprinus carpio L*." reared in an indoor system.

Materials and methods

Feed formulation: The Jabal AKheyrat Feed Company provided the experimental diets, which were designed to have 6% crude lipid and 32.2% crude protein. The experimental diets' dietary formulations are shown in Table 1. Approximate compositions of the experimental diets are shown in Table 2 .

Table 1: Formulation of the experimental diets (based on dry weight)

Ingredient g kg^{-1}	
Soybean	530
Corn	150
Fishmeal	100
Premix	25
Soya oil	50
Wheat flour	100
Wheat bran	33
Vitamin Premix	11
Enzyme	1

Table 2: Proximal analysis of the experimental diet (on a dry weight basis)

Parameters	g/kg
Moisture	88
Crude protein	322
Crude fat	60
Crude ash	67
Crude fibre	36
Starch	401

Experimental condition: The experiments were conducted at Salahaddin University-Erbil, specifically within the Aquaculture Unit located at the Grdarasha Station of the College of Agricultural and Engineering Sciences. An experimental indoor environment was used for the trials. In this experiment, twelve 200 L fiberglass tanks were used. There was adequate, ongoing aeration in every tank. There were ten fish in each tank. Fish (initial mean 104.16 ± 0.83 g) were arranged at random into 200 L tanks, each of which had a single inlet pipe to create dissolved oxygen. A low-noise air pump (RESUN, Model: LP-60) connected all of the pipes. Well water was regulated by four methods: 25% well water was replaced with treated sewage (25% TW), 50% well water was replaced with sewage treated water (50% TW), and 75% well water was replaced with sewage treated water (75% TW). The experiment was conducted using a photoperiod that included 12 hours of light followed by 12 hours of darkness. Each tank received a daily water exchange of 10% using a mixture of well water and treated sewage water according to treatment group (0%, 25%, 50%, or 75% treated water). Additionally, at the end of each week on the weighting day, the tanks' water was completely drained and refilled with sewage-treated water in the amounts of 0%, 25%, 50%, and 75% of the well.

Water quality: The levels of TSS, COD, BOD, nitrate and ammonia in sewage water before and after biological treatment are shown in Table 3.

Daily measurements of dissolved oxygen were conducted for each tank individually utilizing the DO meter model (TRANS instruments, DO 9100). Daily pH measurements for each tank were conducted individually using an electrometric method with a portable pH meter (model HANNA instruments, HI98129, CE; manufactured in Romania). Daily measurements of temperature, electrical conductivity (E.C.), total dissolved solids (TDS), salinity, and resistivity for each tank were conducted using a meter model (Model SX713, China).

Water samples from each tank were gathered at 10 am during the fourth week using 1.5-litre acid-washed polypropylene containers. These samples were subsequently transported to the laboratory for analysis. Turbidity, pH, electrical conductivity, total dissolved solids, chloride (as Cl^-), sodium (as Na^+), potassium (as K^+), calcium (as Ca^{2+}), magnesium (as Mg^{2+}), total hardness, total alkalinity, nitrate (as NO_3 $^-$) and sulphate (SO_4 $^{-2}$) were determined in the lab. A water sample was collected to assess the concentration of heavy metals in the experimental water from each tank.

Table 3: Physical and chemical properties of sewage water before and after treatment

Parameters	Before treat	After treat
Total suspended solids (TSS) mg/L	29	34
Chemical oxygen demand (COD) mg/L	125	68
Biological oxygen demand (BOD_5) mg/L	82.1	32.1
Nitrate (NO^{-3}) mg/L	54.9	34.6
Ammonia mg/L	12.8	4.9

Fish and husbandry: This research utilized common carp, which were sourced from a private hatchery located in Erbil, Iraq. The fish were transported to an aquaculture facility where they underwent a 14-day acclimatization period to the indoor environment. During this time, they were provided with a maintenance diet containing 32% protein and 6% fat. A total of 120 fish, averaging 104.16±0.83g, were randomly assigned to 12 tanks. The fish were fed experimental diets three times daily, with the feeding amount set at approximately 3% of their body weight. Weekly, the fish were weighed to monitor growth. Following a full day of fasting, the feed quantity was adjusted according to the weight of each tank.

Experimental design: The experiment involved twelve rectangular fiberglass tanks housing a total of 120 common carp, with an average weight of 104.16±0.83g, distributed as ten fish per tank across three tanks for each group. A completely randomized design (CRD) was used for the current study. Three of the four fish groups were raised in water that was 25, 50%, and 75% well water that had been replaced with sewage-treated water.

Blood sampling: Blood samples were taken from six fish from each treatment group at the end of the study. The fish were not fed for 24 hours prior to sampling. Blood samples were taken from the fish heart without killing fish. The blood samples were placed in the clot activator and sun-val, and then placed on ice, immediately placed in the centrifuge at 3,500 degrees for 15 minutes, and the serum obtained from the supernatant was labelled in eppendorf tubes stored at -80 degrees Celsius for biochemical tests and thyroid hormone determination.

Biochemical analysis: Measurements were made using Cobas c111 for biochemical tests, including cholesterol, AST, ALT, TG, ALP, HDL, LDL, VLDL, urea, uric acid, total protein, albumin, creatinine, lipase, amylase, globulin, and glucose.

Chemical analysis: The diets and fish samples from the feeding experiment were analyzed. At the end of the study, two fish from each tank

(totaling six fish per treatment) were selected for whole body analysis. These samples were ground and homogenized using a blender before conducting chemical assays. Each sample was analyzed three times.

The material was dried in a fan-assisted oven at 105 °C until a stable weight was achieved, allowing for the measurement of moisture content (dry matter). The ash content, representing total mineral or inorganic mineral, was assessed by incinerating the samples for eight hours at 550 °C in a muffle furnace until light grey ash or a constant weight was attained. Crude protein (calculated as N×6.25) was determined using the automated Kjeldahl method following acid digestion with a Gerhardt system. The lipid content was measured in triplicate through rapid extraction via the Soxhlet method.

Growth and feed utilization calculations: To determine growth parameters, the total biomass of fish in each tank was individually weighed at both the beginning and conclusion of the experiment. The data collected from each group facilitated the calculation of growth rates, feed consumption, and mortality rates. The assessment of fish growth performance and feed utilization was conducted using the following formulas:

Specific Growth Rate (SGR %) = (In FBW – In IBW) / T × 100

Feed Conversion Ratio (FCR g) = (Feed intake (g)) / (weight gain (g))

Survival Rate = 100 – (Mortality) = Final Nb / /Initial Nb×100)

Table 4: Growth performance and feed utilization of experimental fish for 8 weeks (n=3)

Parameters	C	TW 25%	TW 50%	TW 75%
IBW (g)	104.33± 0.66[a]	104.00± 0.57[a]	104.0± 0.57[a]	104.33± 0.33[a]
FBW (g)	152.06± 3.77[a]	147.44± 1.16[ab]	142.26± 0.75[b]	146.36± 3.41[ab]
WG (g)	47.73± 3.99[a]	43.44± 1.02[a]	38.26± 1.29[a]	42.02± 3.66[a]
SGR %	0.67± 0.04[a]	0.63± 0.01[a]	0.55± 0.01[a]	0.59± 0.04[a]
FCR	3.85± 0.34[a]	4.09± 0.12[a]	4.66± 0.28[a]	4.57± 0.28[a]
Survival %	100± 0.00[a]	96.66± 3.33[a]	90.0± 5.77[ab]	83.33± 3.33[b]

Statistical analysis: The data underwent a one-way ANOVA statistical analysis utilizing the Statistical Package for Social Sciences (SPSS, version 26, IBM Corporation, 2019). Results are expressed as mean values ± standard error (mean ± SE). To identify significant differences among treatments, the Duncan test was used with a significance level of 0.05 (Duncan, 1995)

Results and Discussion

Growth performances: The growth performance, feed utilization, and survival of the experimental fish are displayed in Table 4. Fish raised in tanks with 50% well water replaced with treated sewage water had significantly lower FBW ($P\leq0.05$). The decrease observed was not statistically significant ($P\geq0.05$) when 25% and 75% of well water were replaced. The substitution of well water with treated sewage water did not result in any significant effects ($P\geq0.05$) on weight gain (WG), specific growth rate (SGR), or feed conversion ratio (FCR). This finding aligns with the results of study [18], which indicated that the growth of guppy *Poecilia reticulata* was not notably affected by treated wastewater

Data are presented as (Mean ± SE).

Data in the same row with different subscript are significantly different ($P\leq0.05$)

Theapplication of treated sewage in aquaculture is linked to longstanding practices in fish farming, especially concerning species such as carp and tilapia. In alignment with the findings of the present study, research conducted by [6] indicated that the growth performance of fish remained unchanged when treated household sewage water was used in varying proportions of 0%, 25%, 50%, 75%, and 100% in place of well water. The fish raised in water where 75% of well water was substituted with treated sewage exhibited the lowest survival rate, which was significantly lower than that recorded in both the control group and the other fish groups. The high mortality at 75% of the sewage concentration may be due to high BOD (4.20 mg per L). According to the current study, [19] found that three fish species—the rohu (*Labeo rohita Hamilton*, 1822), the mrigal (*Cirrhinus mrigala Hamilton*, 1822), and the bata (Labeo bata Hamilton, 1822)—had a significantly lower survival rate when 75% of their well water was replaced with sewage water.

Water quality: Sewage effluent contains both nutrients and pollutants; it is therefore necessary to integrate sewage effluent properly into fish farming systems in order to ensure an appropriate water quality for fish growth [20]. A comparison of treated and untreated sewage water revealed that treated water had reduced levels of ammonia, nitrate (NO^{-} ^{3}) mg/L, chemical oxygen demand (COD), and biological oxygen demand (BOD_5) (Table 3). Table 4 displays the changes in the experimental water's physical-chemical characteristics during the experiment. The study found that substituting well water with sewage-treated water had no significant ($P\geq0.05$) effect on temperature, which varied between 22.36 and 22.6 °C. This agrees with [19]. Replacing well water with sewage-treated water did not significantly influence pH, dissolved oxygen, or turbidity ($P\geq0.05$) when compared to the control group.

Substituting well water with sewage water resulted in significant ($P<0.05$) increases in biological oxygen (B.O.D.), EC, nitrate ((NO_3^{-}), Na^{+} , TDS, COD, and K^{+} . This is contradicts [6] who stated that treated dwellings sewage water considerably reduced BOD and nitrate levels. No significant differences in alkalinity, total hardness, calcium, SO_4 and nitrate (NO_3^{-}) were found when the well water was replaced by sewage water. CL and TSS levels increased significantly ($P<0.05$) when 50% and 75% of the well water was replaced by sewage treated water. The recommended water quality standards for aquaculture to promote optimal fish growth and health have been defined, and for carp, they are as follows: ammonia, nitrite, and nitrate levels below 0.05, 0.5, and 80 mg/L, respectively [21]. Value of ammonia ranged (15.94-13.83) which is too high for culture fish and not acceptable for culture common carp [22, 21], it was also significantly ($P\geq0.05$) decreased by replacing well water with sewage-treated water in comparison with the control group. In contrast to present finding [11, 2] reported that in sewage incorporated systems, total ammonia levels were higher than in controls.

Table 5: Physical and chemical properties of sewage water before and after treatment

Parameters	Before treat	After treat
Total suspended solids (TSS) mg/L	29	34
Chemical oxygen demand (COD) mg/L	125	68
Biological oxygen demand (BOD_5) mg/L	82.1	32.1
Nitrate (NO^{-} ^{3}) mg/L	54.9	34.6
Ammonia	12.8	4.9

Table 6: Mean values for water quality parameter in experimental system (n=3).

Parameters	C	TW 25%	TW 50%	TW 75%
Temperature	22.55± 0.05[a]	22.60± 0.006[a]	22.45± 0.06[a]	22.36± 0.15[a]
Ph	7.47± 0.1[a]	7.55± 0.11[a]	7.63± 0.09[a]	7.74± 0.07[a]
D.O	4.75± 0.3[a]	4.86± 0.47[a]	4.82± 0.16[a]	4.84± 0.47[a]
Turbidity	38.16± 7.57[a]	39.46± 5.52[a]	28.86± 9.34[a]	18.80± 5.49[a]
B.O.D	0.50± 0.02[d]	1.45± 0.02[c]	1.60± 0.05[b]	4.20± 0.05[a]
EC	671.73± 2.28[d]	774.07± 6.46[c]	882.01± 13.3[b]	990.85± 6.12[a]
Nitrate (NO_3^{-}) mg\L	11.32± 0.15[d]	16.84± 0.02[c]	25.63± 0.17[b]	36.74± 0.21[a]
Ammonia	15.94± 0.12[a]	12.74± 0.07[d]	14.62± 0.24[b]	13.83± 0.22[c]
Alkalinity	217.33± 29.7[a]	235.33± 4.66[a]	248.00± 4.16[a]	243.66± 17.13[a]
T. Hardness	242.66± 7.21[a]	244.0± 8.08[a]	237.66± 18.94[a]	275.00± 5.13[a]
Ca	60.33± 1.85[a]	60.66± 2.02[a]	59.33± 4.70[a]	68.66± 1.20[a]
Mg	22.66± 0.66[ab]	23.33± 0.88[ab]	22.33± 1.66[b]	26.00± 0.57[a]
CL	18.66± 1.76[b]	23.66± 3.71[b]	33.00± 2.88[a]	41.66± 2.02[a]
SO_4	162.33± 3.17[a]	153.33± 4.40[a]	188.00± 24.0[a]	165.33± 7.96[a]
Na^+	52.33± 1.91[d]	63.53± 1.67[c]	73.23± 0.90[b]	84.16± 3.63[a]
K^+	6.60± 0.49[c]	7.40± 0.55[bc]	9.36± 0.43[ab]	10.06± 1.19[a]
No_3^{-}	18.66± 1.45[a]	19.33± 2.33[a]	21.00± 0.57[a]	25.00± 3.51[a]
TDS	337.11± 1.58[d]	386.93± 3.29[c]	446.13± 2.55[b]	504.30± 7.26[a]
TSS mg\L	0.12± 0.0057[c]	0.13± 0.0057[c]	0.16± 0.0057[b]	0.21± 0.0057[a]

COD	21.00± 0.57[d]	40.33± 0.88[c]	99.00± 0.57[b]	141.33± 1.85[a]
Salinity	0.030± 0.0001[d]	0.032± 0.0[c]	0.039± 0.0003[b]	0.045± 0.00[a]

Data are presented as (Mean ± SE).
Data in the same row with different subscript are significantly different ($P \leq 0.05$)

Biochemical parameters: In aquaculture systems, serum biochemical parameters are key indications of fish health [23]. Biochemical parameters in the serum of experimental fish are shown in table (5). The level of aspartate transferase (AST) increased significantly ($P \leq 0.05$) when 25% and 50% of well water were replaced with sewage-treated water, but declined significantly ($P \leq 0.05$) when 75% of well water was replaced with sewage-treated water. This is in line with [24], who found a substantial rise in AST activity in plasma from common carp exposed to municipal effluent. The increase in AST activity in plasma might be attributed to liver damage, which causes the release of intercellular enzymes and elevated plasma aminotransferase levels [25]. Another reason of high AST is increased cell membrane permeability, also known as hepatocyte cell membrane injury.

Fish reared in water when 50% of well water was replaced with sewage-treated water, alanine transaminase (ALT) levels increased significantly ($P \leq 0.05$) compared to the control group. However, 75% substitution resulted in a considerable drop. As stress enzymes, the level of ALT and AST increased in common carps when salt levels rise, indicating that the fish were under stress. Additionally, both enzymes would rise as a result of protein breakdown, especially in the liver [25].

The level of ALP was significantly reduced when 50% and 75% of well water were replaced with sewage-treated water. This is in line with [24], who found that common carp exposed to city wastewater had much less activity in their plasma. Hepatic changes may be linked to a decrease in ALP [26]. The substitution 75% of well water with sewage-treated water significantly elevated cholesterol levels. The use of sewage-treated water instead of well water considerably increased the amount of TG. The current study's increased blood triglyceride and cholesterol levels might be related to an increase in lipid mobilization to meet the growing energy demand to deal with the stress of wastewater toxicity. The level of HDL was significantly decreased by substituting 50% of well water with sewage treated water, nevertheless, significantly increased by substituting 75% of well water with sewage treated water. The amount of LDL in the serum of experimental fish was not significantly impacted by substituting well water by treated sewage water. The level of VLDL was significantly elevated when 50% and 75% of the well water was replaced with treated sewage water. According to the current findings, the toxicity in the kidneys of fish grown in water containing treated sewage water was reflected in plasma creatinine and urea levels. The amount of urea was significantly decreased by replacing 50% and 75% of well water with treated sewage water.

The reasons for decreasing urea production might be due to liver failure or increased fluid loss. The amount of uric acid increased significantly when 25% and 75% of the well water were replaced with treated sewage water. Protein is an essential component of cells and tissues because it plays a crucial part in the physiology of organisms [24]. The value of total protein reduced considerably when 75% of well water was replaced with treated sewage water. Reducing total protein indicates higher mobilization of protein stores in response to stress. Albumin is the most abundant multifunctional single chain protein in blood plasma [27]. The level of albumin was significantly decreased with substituting 75% of well water with treated sewage water.The reasons for decreasing in total protein and albumin level when 75% of well water was replaced by sewage treated water might be due to increased protein breakdown due to stress, inhibited protein synthesis and liver damage. Additionally, reducing albumin levels might be attributed to the influence of chemical substances present in waste water on albumin's biological structure. Furthermore, reduction in plasma albumin levels of fish reared in water replaced with sewage treated water might be attributed to decrease in total protein levels.

Replacing well water with treated sewage water had no significant effect on the creatinine and globulin levels in the serum of experimental fish. Lipase levels increased significantly when 75% of well water was replaced with sewage-treated water, but dropped significantly when 25% of well water was replaced with sewage-treated water.

The level of amylase increased significantly when 50% and 75% of well water were replaced with sewage treated water, but decreased significantly when 25% of the well water was replaced with sewage treated water. The glucose level was significantly raised by substituting 75% of the well water with sewage-treated water. In line with the present study, a significant increase in plasma glucose levels in *C. carpio* was reported after exposure to the municipal wastewater [24]. Increased blood glucose levels in fish reared in 75% well water mixed with sewage-treated water may indicate a heightened demand for energy to mitigate the stress effects caused by pollutants in wastewater; however, these levels were significantly reduced when 25% and 50% of the well water was substituted with sewage-treated water.

Table 7: Biochemical parameters in serum of experimental fish (n=6).

Parameters	C	TW 25%	TW 50%	TW 75%
AST U/L	227.93± 1.06[b]	254.56± 0.97[a]	257.06± 0.78[a]	200.70± 1.11[c]
ALT U\L	18.36± 0.59[b]	19.03± 0.46[ab]	20.70± 0.75[a]	11.90± 0.32[c]
ALP U\L	28.10± 0.51[a]	30.30± 1.15[a]	13.63± 0.67[b]	8.03± 0.29[c]
Cholesterol mg/dl	135.66± 1.45[b]	128.33± 1.45[c]	139.50± 0.86[b]	161.50± 1.32[a]
TG mg\dL	237.40± 1.47[c]	251.0± 4.58[b]	337.33± 0.88[a]	333.66± 2.33[a]
HDL mg\dL	12.46± 0.26[b]	12.23± 0.14[b]	8.46± 0.14[c]	13.60± 0.55[a]
LDL mg\dl	98.26± 2.35[a]	96.26± 0.93[a]	97.73± 0.83[a]	101.23± 1.33[a]
VLDL	26.63± 0.37[bc]	25.76± 0.56[c]	27.76± 0.24[b]	32.20± 0.55[a]
Urea mg/dL	8.10± 0.10[a]	8.20± 0.20[a]	5.20± 0.05[b]	5.93± 0.08[c]
Uric acid mg/dL	0.10± 0.01[b]	0.20± 0.02[a]	0.10± 0.00[b]	0.20± 0.01[a]
Total protein g/dL	4.70± 0.10[a]	4.50± 0.20[a]	4.66± 0.08[a]	3.93± 0.08[b]
Albumin	1.73± 0.12[a]	1.83± 0.03[a]	1.60± 0.15[a]	1.10± 0.11[b]
Creatinie mg/dL	0.04± 0.008[a]	0.15± 0.057[a]	0.17± 0.059[a]	0.16± 0.062[a]

Data are presented as (Mean ± SE).
Data in the same row with different subscript are significantly different (*P≤0.05*)

Conclusion

In conclusion, the current study offers physiological information on the possibility of the use of sewage-treated water to partially replace well water. Growth performance was unaffected when sewage-treated water was used in place of well water. Furthermore, the blood biochemical parameters of common carp were significantly impacted when well water was substituted with sewage-treated water. Additionally, it was determined that common carp raised on sewage-treated water instead of well water experience disruptions in homeostasis and changes in blood biochemistry. It significantly affected the experimental water quality as well. The effects of partially substituting well water for sewage-treated water in various culture systems, species, and locations require more investigation.

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تأثير الاستبدال الجزئي لمياه الآبار بمياه الصرف الصحي المعالجة على جودة المياه والاستجابة الفسيولوجية في أسماك الكارب الشائع Cyprinus carpio L.

شيرين عثمان أحمد [1]   **أيوب يونس أنور** [2]

قسم الثروة السمكية والحيوانات المائية، كلية علوم الهندسة الزراعية، جامعة صلاح الدين، أربيل، إقليم كردستان، العراق[1].

قسم الثروة السمكية والحيوانات المائية، كلية علوم الهندسة الزراعية، جامعة صلاح الدين، أربيل، إقليم كردستان، العراق[2].

الخلاصة

تدرس الدراسة آثار استبدال مياه الآبار بمياه الصرف الصحي المعالجة على جودة المياه وأداء النمو وتركيب الذبيحة ومعايير الدم في أسماك الكارب الشائع. تم تربية أسماك الكارب الشائع (متوسط الوزن = 104.16 ± 0.83 جم) في 12 حوضًا تجريبيًا، حيث تم استبدال مياه الآبار بنسبة 0٪ و25٪ و50٪ و75٪ من مياه الصرف الصحي المعالجة. أظهرت النتيجة أن الوزن النهائي للجسم (*FBW*) انخفض بشكل كبير في الأسماك التي تم تربيتها في أحواض مع استبدال 50٪ من مياه الآبار بمياه الصرف الصحي المعالجة. لم يتم العثور على فرق كبير بين المعاملات في قيم زيادة الوزن (*WG*) ومعدل النمو النوعي (*SGR*) ونسبة التحويل الغذائي (*FCR*). تم تسجيل أدنى مستوى للبقاء على قيد الحياة (83.33 ± 3.33) في الأسماك التي تم تربيتها في الماء مع استبدال 75٪ من مياه الآبار بمياه الصرف الصحي المعالجة، وهو أقل بكثير من المجموعة الضابطة ومجموعات الأسماك الأخرى. أدى استبدال مياه الصرف الصحي المعالجة بمياه الآبار إلى ارتفاع مستويات الطلب البيولوجي للأكسجين (*BOD*)، والتوصيل الكهربائي (*EC*)، وأكسيد النيتروجين (NO_3□)، والطلب الكيميائي للأكسجين (*COD*)، والمغنيسيوم (*Mg*)، والكلوريد (*Cl*)، والصوديوم (□*Na*)، والبوتاسيوم (□*K*)، والمواد الصلبة الذائبة الكلية (*TDS*)، والمواد الصلبة العالقة (*TSS*)، والملوحة. ومع ذلك، انخفضت مستويات الأمونيا بشكل ملحوظ مع زيادة مستوى الاستبدال. أظهرت الاختبارات الكيميائية الحيوية في المصل تغيرات كبيرة مع استبدال مياه الآبار بمياه الصرف الصحي المعالجة. ارتفعت مستويات *AST* و*ALT* و*ALP* والكوليسترول والثلاثي الدهني ثلاثي الجليسريد (*TG*) والكوليسترول الجيد (*HDL*) والكوليسترول منخفض الكثافة (*VLDL*) واليوريا وحمض اليوريك والبروتين الكلي والألبومين والليباز والأميليز والجلوكوز مع استبدال 75% من مياه الآبار بمياه الصرف الصحي المعالجة. وخلصت الدراسة إلى أن استبدال مياه الآبار بمياه الصرف الصحي المعالجة كان له تأثير كبير على جودة المياه والاختبارات الكيميائية الحيوية في المصل، ولكن لم يكن له تأثير على أداء النمو أو تركيبة الذبيحة.

الكلمات المفتاحية: مياه الصرف الصحي، سمك الشبوط الشائع، أداء النمو، جودة المياه، المعايير الكيميائية الحيوية.