



Effects of Monoculture and Polyculture Systems on Common Carp (*Cyprinus carpio*) Growth and Health in Earthen Culture Ponds

¹Bakhan Rafiq Hassan

1. Department of Animal Science, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaymaniyah, Iraq

ARTICLE INFO.

Article history:

-Received: 5/9/2025

-Received In Revised Form:20/10/2025

-Accepted: 25/10/2025

-Available online:30/6/2026

Keywords:

Feed Utilization, Grass Carp, Silver Carp, Survival, Weight Gain.

Corresponding Author:

Name:

Bakhan Rafiq Hassan

E-mail:

bakhan.hassan@univsul.edu.iq

Tel:07702302627

ABSTRACT

Background and Objective: in Iraq, freshwater aquaculture is mostly practiced in earthen ponds, where farmers use a traditional rearing method of producing *Cyprinus carpio* in monoculture. Therefore, the primary goal of this study is to evaluate the growth patterns and some health-related characteristics of common carp in both monoculture and polyculture systems to assist fish farmers in increasing their production.

Material and methods: Six earthen ponds (2500 m²) at a private fish farm were used as the site of the 6-month experiment. Three ponds were used to stock 1300 common carp (initial body weight of 35 ± 5 g) in monoculture, while the other three ponds were used for cultivating 1000 common carp, 150 grass carp, and 150 silver carp in polyculture. An artificial pelleted diet was given to common carp. Every month, measurements were taken from each of the fish and rearing ponds for important water quality parameters, growth, feed conversion ratio, and determining some biological and health parameters.

Results: The findings showed that the water quality parameters (water temperature 22 to 30.1°C, dissolved oxygen 5 to 6.9 mg/l, and pH 7.2 to 7.7), were all within the range that was appropriate for fish farming. When compared to monoculture, the common carp in polyculture had better weight gain, daily weight gain, and specific growth rate (2400 g, 13.33 g, and 2.35, respectively). Additionally, common carp in polyculture showed a higher feed conversion ratio (1.57). Furthermore, the survival rate of the polyculture is greater than that of the monoculture. The hepatic somatic index and condition factor, however, did not show any significant effects.

Conclusion : In conclusion, common carp raised in a polyculture system with silver carp and grass carp increase in growth and survival rates without affecting their general health.

Introduction

Aquaculture techniques such as monoculture and polyculture are frequently employed in fisheries-related economic projects due to their efficiency and ability to facilitate land utilization. Aquaculture systems that use a single type of commodity, which may be harvested once a year or more frequently, depending on the commodity, are known as monoculture systems. A polyculture occurs when more than one aquatic species are cultivated in the same body of water [1]. In monoculture systems, extra nutrients from leftover food alter the dynamics of dissolved oxygen and raise the concentrations of phytoplankton and ammonia [2]. However, polyculture enhances water quality, which boosts the performance of the primary cultivated species by adding a secondary or subordinate species [3]. As a result, it maximizes the use of available resources, lowers the activity's environmental effect, boosts producer profitability, and offers advantages linked to enhanced ecological stability and function [4, 5]. Additionally, using cleaner fish reduces waste through the recycling of byproducts from other species or through efficient use of space [6]; as a result, polyculture can also present intriguing substitutes for medication treatments by encouraging direct biotic interactions [7]. From omnivores to fish species that feed on macro-vegetation, as well as from column feeders to benthic feeders, a suitable mix of species with varied eating habits should be incorporated [8]. Therefore, choosing the right fish species for polyculture is crucial.

According to the [9], the common carp (*Cyprinus carpio*) is the third most extensively farmed and economically significant freshwater fish species worldwide. Due to its better market value and customer desire, common carp is now preferred by farmers to stock; also they easily accept artificial feed when it is given to them [10]. Because of these characteristics, common carp are a viable option for both monoculture and polyculture ponds [11]. Grass carp (*Ctenopharyngodon idella*) are herbivores that eat a lot of higher aquatic plants. They can be raised without the use of expensive artificial feeds by supplying fish with edible leaves and entire soft plants, either aquatic or terrestrial [12]. Silver carps (*Hypophthalmichthys molitrix*) are well-known for their rapid growth and broad popularity. In addition to being employed to rid waterways of algal blooms, they are frequently marketed for human consumption [13]. It is crucial that the feeding habits of polyculture species do not clash and that their environmental

needs are similar. Common carp, grass carp, and silver carp were chosen for experimental usage in polyculture systems due to their quick growth rate, resistance to disease and poor water quality, and ability to withstand a variety of environmental factors. According to [14], carp polyculture has the most potential for enhancing fish production when compared to other methods. Freshwater aquaculture in Iraq is mostly carried out in earthen ponds, where farmers produce *C. carpio* in monoculture as a traditional rearing method. As a result, the primary goal of this study is to evaluate the growth patterns and some health-related characteristics of common carp, a popular crop that is raised in both monoculture and polyculture systems as a new way for fish farmers to increase their production.

Materials and Methods

Study site and pond preparation

The 6-month experiment was carried out in six earthen ponds at a private fish farm in Mara Rash village, Sharbazher District, Kurdistan Region, Iraq, from April 20 to October 20, 2024. Every pond had a rectangular form, measured 2500 m², and had an average depth of 1.3 m. Water from the stream fed the ponds. Every pond was cleansed, and its aquatic vegetation removed, before the experiment was carried out. One week before stocking, 40 kg of poultry dung was added to each pond to fertilize it. Each pond's water inlet and outlet pipes were covered with nylon screens to keep undesirable fish from entering or allowing cultivated fish to escape. To prevent the impact of water level variations, the pond's water was kept at a constant level of around 1 meter during the research period and was checked every week. To determine if the ponds were damaged, their conditions were checked as well.

Experimental design and fish stocking

In this study, six earthen fishponds were used. Common carp were stocked in monoculture in three ponds, while common carp, grass carp, and silver carp were cultivated in polyculture in the remaining three ponds. The private fish farm in the Iraqi city of Hillah, in the Babil Province, was the source of the fish. From the hatchery, a specialized vehicle carried the fish fry to the experimental location. Ponds were allocated to a treatment at random, and the study design included two treatments with three replications. The following treatments were employed in this study:

Monoculture: 1300 common carp (weight 35 ± 5 g).

Polyculture: 1000 common carp (weight 35 ± 5 g), 150 grass carp (weight 27 ± 2 g), and 150 silver carp (weight 22 ± 2 g).

The fish's movement, colors, infections, and diseases were all identified by regular activity monitoring, especially after morning and evening feedings. There were no medicines or antibiotics given during the experiment period. Fish that were dead were removed right away, and over the duration of the study, their survival rates were recorded.

Feed and Feeding System

The artificial pelleted feed, which included around 32% crude protein, was provided to all

fish groups. Table 1 lists the components of the artificial diet along with their chemical compositions. During the five months of the experiment, feeding was done twice a day, in the morning and the evening, at a rate of 5% of body weight mass. Toward the conclusion of the trial, the feeding frequency dropped to 4% of body weight mass. After weighing at least 10% of the common carps using a digital weighing instrument, feeding rates per pond were modified every month. Each sample was taken after the fish had fasted for a full day. Demand feeders were used to feed the fish.

Table 1: Experimental feed formulation and chemical analysis (% on a dry matter basis) for common carp in monoculture and polyculture.

Ingredients	Inclusion level (%)	Proximate analysis	
Soybean meal	40	Crude protein (%)	32.4
Crushed chickpeas	10	Ether extract (%)	4.2
Wheat	35	Crude Fiber (%)	2.6
Fish meal	10	Ash (%)	7.3
Vitamin premix	2.5	Moisture (%)	10.3
Mineral	2.3		
Antitoxin	0.2		
Total	100		
Size	4 – 6 mm		

Monitoring of Water Quality Parameters

Every month, measurements were taken from each of the fish rearing ponds for important water quality parameters that affect fish production, including temperature (°C), dissolved oxygen (mg/l), and water pH values. The water's temperature was recorded using a thermometer, its dissolved oxygen content was tested using an oxygen meter model (OAKTON Singapore), and its pH levels were measured using a Germane pH meter.

Evaluation of growth performance.

At the conclusion of the experiment, six months after the fish had been cultivated, from each pond, 50 fish were chosen at random to have their weight and length measured. The growth and feed conversion ratios were calculated using the following formulas:

- Weight gain (g) = $W_2 - W_1$

W_2 : Weight of the fish at the end of the experiment

W_1 : Weight of the fish at the beginning of the experiment

- Daily weight gain (g) = $(W_2 - W_1) / T$

T: the time between W_2 and W_1 (180 days)

- Specific growth rate (SGR) % = $(\ln W_2 - \ln W_1) / T \times 100$

- Feed conversion ratio (FCR) = Total feed fed (g) / Total wet weight gain (g).

Some Biological and Health Parameters

After the study was completed, twenty fish were randomly selected from each pond to be used for anatomical measurements. After dissecting each fish specimen, the abdominal cavity was opened to allow for each organ's independent weight. The following formula was used to determine the measurements:

- Survival rate = (final fish number / initial fish number) x 100

- Fulton condition (K) factor = (fish weight g / fish length cm^3) x 100

- Viscera somatic index (VSI, %) = (viscera weight g / fish weight g) x 100

- Hepatic somatic index (HSI, %) = (liver weight g / fish weight g) x 100

- Spleen somatic index (SSI, %) = (spleen weight g / fish weight g) x 100.

Data analysis

Normality of distribution and homogeneity of variances among different treatments

were confirmed by the Shapiro–Wilk’s test and Bartlett’s test, respectively. Data on fish health and growth under different treatments were submitted to one-way analysis of variance (ANOVA) using XLSTAT Pro 7.5. Duncan’s multiple range tests was used after the ANOVA if the main effect was shown to be significant. A p-value less than 0.05 was considered statistically significant. All measured variables’ values have been shown as mean ± SD.

Table 2: Water quality variables obtained from the two treatment ponds throughout the 180-day research period.

Parameters	Monoculture			Polyculture		
	TEM. (°C)	DO (mg/l)	PH	TEM. (°C)	DO (mg/l)	PH
April	22.5	6.3	7.4	22	6.2	7.6
May	24.8	5.9	7.7	24.6	5.9	7.7
June	25.3	5.7	7.4	25.1	6	7.6
July	29	5.2	7.4	29	5.4	7.3
August	30	5	7.3	30.1	5.4	7.2
September	28	5.3	7.5	27.8	5.9	7.2
October	24	6	7.4	24	6.3	7.3

Enabling farmers to achieve optimal fish growth and production in order to maximize profits is the goal of fish farming. Fish eating, growth, and other biological processes are all completely dependent on water, follows that water quality management is crucial to the success of fish farming [15]. One of the outside variables that significantly affect the aquatic ecosystems’ biota is temperature. Directly impacts essential variables including growth, oxygen consumption, food needs, and food conversion efficiency since it impacts all chemical and biological processes [15]. According to [16], fish growth more quickly at warmer temperatures because they need more oxygen and food. Water temperature was found to be high (22–30.1°C) throughout the study time, which may be appropriate for the fish’s better growth. Our findings supported those of [17], who found that fish growth, food intake, and energy use all increase when water temperature rises from 27 to 33°C. In freshwater aquaculture ponds, dissolved oxygen is the most important water quality parameter. Fish growth in ponds can be slowed by dissolved oxygen levels below 5 mg/l [18]. In this study, the polyculture systems’ dissolved oxygen tends to be higher than in the monoculture. The activity of grass carp and silver carp in the polyculture, which consistently consume the grass and plankton in the ponds, is thought to be the cause of this. As a result, the ponds are cleaner and the water circulation is more efficient, which affects the appetite and

Results and Discussion

Water quality parameters

Table 2 illustrates the values of the water quality variables that were assessed in monoculture and polyculture ponds, including water temperature, dissolved oxygen, and pH. Throughout the trial, the water’s temperature ranged between 22 and 30.1°C. The dissolved oxygen levels ranged from 5 to 6.9 mg/l, and the pH values were between 7.2 and 7.7.

promotes the growth of common carp [19]. In fish farming systems, pH is a crucial water quality measure, as it influences how harmful other substances, including chlorine and ammonia, are to fish [20]. A very low pH is harmful to aquatic life; conversely, a high pH can raise the amount of ammonia in the water, which is also harmful to aquatic life. The average pH range found in this study is 7.2–7.7, falling within the 6.5–9.0 range that is advised for aquaculture pond waters [21]. Every water quality parameter that was measured in this study was found to be appropriate and within the range that was suitable for fish culture [22].

Growth performance and Feed utilization

The effect of different culture systems on the growth trail and feed utilization of common carp was shown in table 3. The effect of culture demonstrated that common carp in polyculture had significantly ($P \leq 0.05$) higher WG, DWG, and SGR (2400 g, 13.33 g, and 2.35, respectively, and better FCR (1.57) when compared to monoculture. Also, according to our results, silver carp has a better growth performance than the other two cultured species (common carp and grass carp) when they are cultured together in a polyculture system, as demonstrated in Table 4.

Table 3: Common carp growth performance and feed utilization (mean ± SD) during 180 days of culture in monoculture and polyculture systems

Parameters	Monoculture	Polyculture
Initial weight average (g)	35.1±0.05 ^a	35.4±0.03 ^a
Final weight average (g)	2185±0.01 ^b	2435±0.02 ^a
Weight gain (WG)(g)	2150±0.04 ^b	2400±0.05 ^a
Daily weight gain (DWG)(g)	11.94±0.04 ^b	13.33±0.01 ^a
Specific growth rate (SGR) (%)	2.29±0.01 ^b	2.35±0.03 ^a
Feed conversion ratio (FCR)	1.66±0.06 ^a	1.57±0.05 ^b

Note: At P≤0.05, means that have different letters in the same row are significantly different.

Table 4: Common, silver, and grass carp growth performance (mean ± SD) during 180 days of culture in polyculture systems.

Parameters	Common carp	Grass carp	Silver carp
Average of initial weight (g)	35.4±0.03 ^a	27±0.05 ^b	22±0.04 ^c
Average of final weight (g)	2435±0.02 ^c	2762±0.07 ^b	2928±0.02 ^a
Weight gain (WG)(g)	2400±0.02 ^c	2735±0.04 ^b	2906±0.01 ^a
Daily weight gain (DWG)(g)	13.33±0.01 ^c	15.19±0.01 ^b	16.14±0.05 ^a
Specific growth rate (SGR) (%)	2.35±0.03 ^a	2.57±0.02 ^a	2.72±0.06 ^a

Note: At P≤0.05, means that have different letters in the same row are significantly different.

Seasonality, food and oxygen availability, stocking density, aquaculture system, age, and other variables all affect the growth rate, which differs between species as well as even within species [23]. The growth rate of common carp raised in polyculture was greater than that of those in monoculture in this study's results. The results gained align with the findings of [24], who observed that the tiger grouper (*Epinephelus fuscoguttatus*) has a higher daily growth rate on polyculture than on monoculture in floating net cages. According to [25], *Glaciarina sp.* grew better in a polyculture with milkfish (*Chanos chanos*) than monocultures based on the average final growth and SGR values. [26] observed that the SGR declined as the density increased, which is similar to our findings.

Mixed fish species may have a role in improving growth performance since they can exhibit symbiotic effects and supply nutrients for other organisms [27]. Fish raised in polyculture improved water quality and increased growth performance, which improved the sustainability of the system and the efficiency of natural food sources, according to [28]. Because of this, species grown in the same pond as part of a polyculture technique tolerate one another's presence, and one species aids in the growth and feeding of the other species more effectively [27]. In a polyculture system, natural feeds from every layer of a body of water are appropriately used. Conversely, such feeds are not used in monoculture systems [4]. Although common carp biomass was lower in polyculture, they benefited from better feed availability in the water column.

This meant that there could have been less competition between common carps as they had larger amounts of food per individual [29]. Furthermore, herbivorous grass carp and planktivorous silver carp in polyculture could utilize grass and moss attached to the line sides and bottom, so the pond's condition was clean and water circulation was good, resulting in increased fish appetite and affecting the growth of common carp. In contrast, the monoculture pond condition, which was lacking of grass and silver carp, appeared unclean due to the buildup of feed remnants and metabolic byproducts, which led to decomposition and foul odors, which would hamper fish eating and growth [24]. Furthermore, as DO vary in the two culture systems, this variation in weight gain might be connected to water quality [15]. According to [30], food and dissolved oxygen are two connected elements that restrict growth, with greater DO levels predicted to show higher growth.

Silver carp can grow rapidly and easily adapt to a variety of habitats, when fed a substantial diet, they can gain 2.7 g each day. Similarly with the obtained results herein, [31] indicated that the highest yield was achieved with silver carp when different carp species, i.e., Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), and silver carp, were cultured together in polyculture, because of the population of plankton raised through fertilization and supplementary feed. Grass carp were introduced to eat the grass directly, unlike other fish species, in order to improve other natural feeds like plankton and benthic invertebrates and provide the system with

nutrients and fertilizer by releasing their waste [8]. Some feed particles always make down to the bottom with uneaten feed, where silver carp can get them. Moreover, common carp feces help create the detrital rain that helps silver carp grow [27], which improves silver carp growth (filter-feeding). These reason maybe the cause of better growth of grass and silver carp in this study.

FCR is an important indicator of fish feed quality that depends on supplied food and water quality. Better feed consumption is indicated by a decreased FCR [32, 33]. In the current study, polyculture outperformed monoculture in terms of FCR values. Our results are in line with those of [34], where Nile tilapia *Oreochromis niloticus* reared in the polyculture system with silver carp revealed the best value of feed conversion ratio. However, [15] raised Nile tilapia alongside African sharp-tooth catfish (*Clarias gariepinus*) in earthen ponds and found no differences in FCR between monoculture and polyculture. Additionally, [24] found that the feed conversion ratio of polyculture tiger groupers is higher than that of monoculture tiger groupers; this could be

because the polyculture tiger groupers have a higher appetite and digestibility value, as they said the higher water quality in polyculture may increase the polyculture tiger groupers' appetite. Feed conversion ratio depends on a number of variables, including the biological value of the feed, the ratio of the main components, stocking density, the fish's genetic line, size and life requirements, water temperature, feeding technique, and frequency; therefore comparing the findings of various studies may not be useful [35].

Biological and health status

The survival rate data of common carp in both mono- and polyculture systems is shown in Figure 1. According to our findings, the polyculture has a higher value of survival rates compared to the monoculture. However, statistical analysis for the survival rate of common, grass, and silver carp shows no significant differences between them when they are cultured together in polyculture (figure 2).

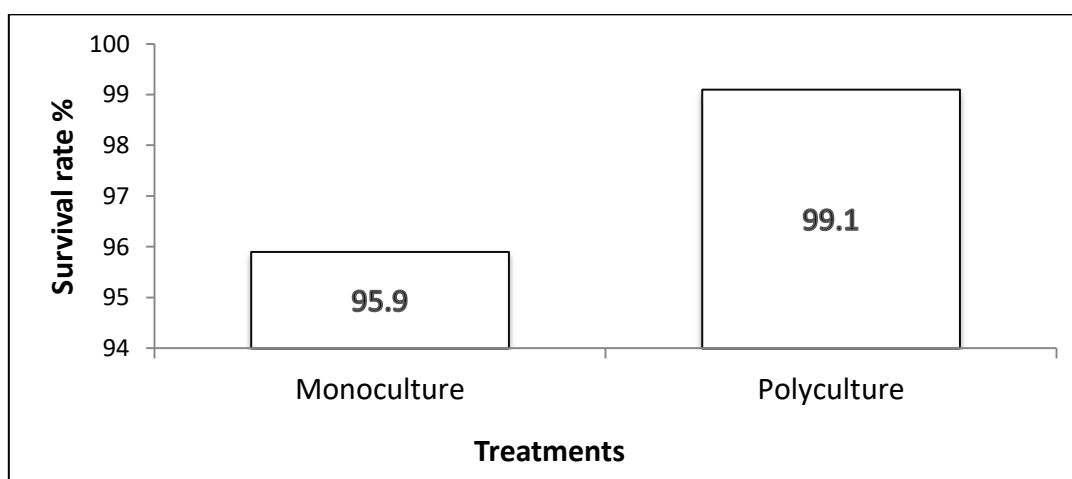


Figure 1: Shows how common carp survival rates are affected by monoculture and polyculture systems over the duration of the culture period.

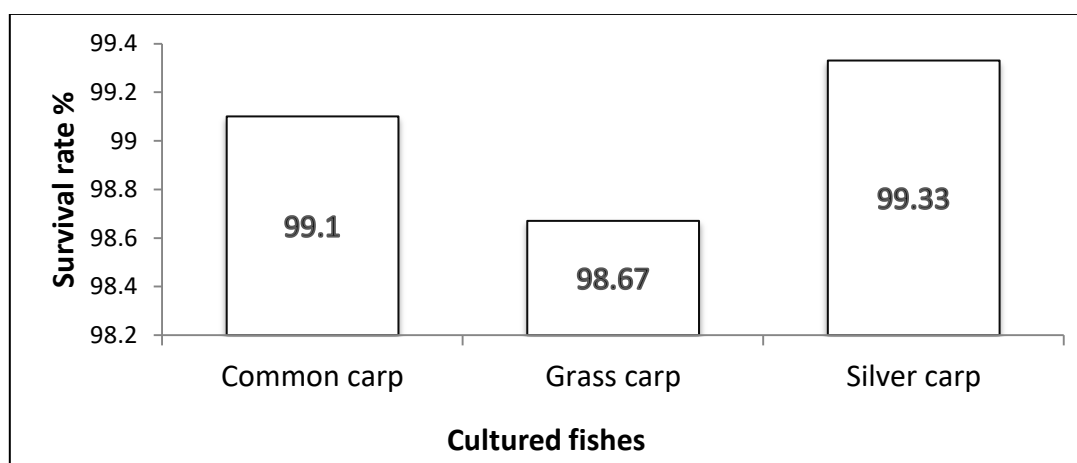


Figure 2: Effect of polyculture on survival rate of carp species during cultured period

The most important factor in the fish-raising process is life-survival value, which is the percentage of fish that survive maintenance as opposed to the original number of fish upon stocking [36]. Numerous biological factors, including genetic materials and management techniques, such as the quality of the food and water, the food's energy content, and the stocking density, affect growth and survival, which combined decide the final yield [37]. According to research by [38], the survival rate of tilapia raised in polyculture is noticeably greater than that of the monoculture. Additionally, the polyculture of carp and tilapia enhanced the pond's net output, survival rate, and water quality, according to [39]. In research by [40], they suggest mixing African sharp-tooth catfish and *Heterobranchus longifilis* in a polyculture system to lower the mortality rate and raise the survival rate in the post-fingerling growth phase. While these findings are consistent with our funding, [41] discovered that striped catfish survival in monoculture was 98.75%; in contrast, it dramatically declined in polyculture with high tilapia proportions. They state that the variation in species proportions and the high stocking density in their study as compared to

previous polyculture proportions may be the cause of this.

A huge amount of feed and fertilizer is typically used in aquaculture systems worldwide, and the leftover feed and biomass metabolic waste release nutrients into water and sediments through microbial decomposition, resulting in hyper-nitrified water bodies [42]. Mass death of farmed fish happens as a result of phytoplankton blooms caused by these excess nutrients in the water body. In order to maintain water quality and increase the survival rate of all cultured fish, polyculture can be a good method to address this issue by promoting the use of various nutrient sources in the water body by various fish food habitats. These facts were also discovered in this study, which showed that the cultured fishes in the polyculture system had high rates of growth, survival, and production.

Table 5 shows the biological and health-related outcomes of common carp in mono- and polyculture. The condition factors and hepatic somatic index in both cultured systems were found to be not significant ($P \leq 0.05$). While common carp in polyculture had higher viscera and spleen somatic indexes of 22.13 and 0.37, respectively.

Table 5: Common carp biological and health parameters after 180 days of growth in monoculture and polyculture systems (mean \pm SD)

Parameters	Monoculture	Polyculture
Fulton condition (K) factor	1.74 \pm 0.02 ^a	1.7 \pm 0.03 ^a
Viscera somatic index (VSI, %)	12.44 \pm 0.04 ^b	14.83 \pm 0.01 ^a
Hepatic somatic index (HSI, %)	2.88 \pm 0.01 ^a	2.57 \pm 0.02 ^a
Spleen somatic index (SSI, %)	0.13 \pm 0.03 ^b	0.25 \pm 0.05 ^a

Note: At $P \leq 0.05$, means that have different letters in the same row are significantly different.

According to [43], the condition factor is typically employed to evaluate the overall health of the fish, both individually and as a population. The condition factor indicates how an individual reacts to environmental factors, including the amount and quality of nutrients as well as the presence of pathogens, pollutants, and toxic substances. This can cause a change in an individual's and organs' mass when compared to individuals from the same environment. Fish in the examined population are in good health if their Fulton coefficient is more than one [44]. The fish in both cultivated systems had a high condition factor (more than one), according to the current study's findings. In contrast to our findings, [45] found that largemouth bass had a greater Fulton's coefficient at the conclusion of the trial (1.09)

than monoculture pikeperch (0.74). They state that the differing body forms and conditions of the two studied fish species are what caused these outcomes rather than the pikeperch's poor condition.

The ratios of organs to body weight are known as organ somatic indices, and they can be directly associated with changes in the environment [46]. The total length and weight of the fish are correlated with the size and weight of its liver, spleen, heart, gonads, and other organs, which also reveal the overall health of the fish. The liver contributes significantly to metabolism and serves as a store of energy. Stressors from the environment have a direct impact on changes in its weight and size [47]. The state of the fish, as well as its physiological and health status,

determined the hepatic somatic index of bony fish belonging to the same species [48]. The spleen somatic index is a useful measure of the immune system's activity level as well as the incidence and severity of diseases and infections since the spleen plays a significant hematological role in vertebrates. A bacterial or parasitic infection is indicated by higher SSI values, whereas a total absence or a moderate sickness is indicated by lower values, which also show that fish are generally in excellent health [47]. According to [41], young striped catfish, *Pangasianodon hypophthalmus*, and Nile tilapia reared in monoculture and polyculture for 14 weeks did not significantly vary in their hepatosomatic and visceral somatic index. Additionally, in the study by [34], no significant impacts were seen on the organ indices and condition factor of *O. niloticus* reared in monoculture or polyculture systems. All growth performance indicators of common carp were greatly enhanced by the polyculture systems, according to this study's findings. However, no significant impacts were found on the condition factor or hepatic somatic index, while the viscera and spleen indices of common carp raised in polyculture were greater. This could be because fish reared in a polyculture system grow more weight, not because their spleen and viscera are bigger. Additionally, the differences observed in the results of multiple studies may be due to a number of variables, including fish species, life stage, age, nutrition, reproductive stage, health, water exchange rate, stocking density levels, interaction with others, and environments [47].

Conclusion

The results of the study demonstrated that raising common carp in a polyculture system with grass and silver carp improves its growth and survival rates without having an impact on their overall health. The study also demonstrates that the rearing ponds' water quality characteristics fall within acceptable standards for *Cyprinus carpio* production. Therefore, we may advise fish farmers to use a polyculture technique for the successful pond culture of common carp. Further research is necessary to determine the optimal and profitable ratio of common, grass, and silver carp with a range of fish sizes.

Acknowledgements

I express my gratitude to Mr. Salah Majid Rasul (Kurdistan Region Fish Resources Development Association's head in Sulaimani City, Iraq) for helping to gather data during the study.

Declaration of interests

the authors declare no competing interests.

Funding Sources

This research received no financial support or specific grant from any funding agency in the commercial, public, or not-for-profit sectors.

Publication consent

Data and material availability

All data analyzed and generated in this study are included in this published research.

Author contribution

All authors participated in the study design and conception, data analysis, data collection, performance of the results, and assent to the final version.

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آثار نظامي الزراعة الأحادية والمتعددة على نمو وصحة سمك الكارب الشائع (*Cyprinus carpio*) في أحواض الاستزراع الترايبية

باخان رفیق حسن¹

1 قسم علوم الحيوان، كلية علوم وهندسة الزراعة، جامعة السليمانية، السليمانية، العراق.

الملخص

الملخص : في هذه الدراسة، تم تقييم أنماط نمو سمك الكارب الشائع (*Cyprinus carpio*) المُربى في نظامي الزراعة الأحادية والمتعددة، بالإضافة إلى بعض الخصائص الصحية. استُخدمت ستة أحواض ترايبية (2500 متر مربع) في مزرعة أسماك خاصة كموقع للتجربة التي استمرت ستة أشهر، من 20 أبريل إلى 20 أكتوبر 2024. استُخدمت ثلاثة أحواض لتخزين 1300 سمكة من الكارب الشائع (بوزن جسم ابتدائي 35 ± 5 غرام) في نظام الاستزراع الأحادي، بينما استُخدمت الأحواض الثلاثة الأخرى لتربية 1000 سمكة من الكارب الشائع، و150 سمكة من الكارب العشبي، و150 سمكة من الكارب الفضي في نظام الاستزراع المتعدد.

النتائج : أعطى الكارب الشائع علفاً صناعياً مُحبباً. أُجريت قياسات شهرية من كلِّ من برك الأسماك والتربية لمعرفة معايير جودة المياه المهمة، والنمو، ونسبة تحويل العلف، وتحديد بعض المعايير البيولوجية والصحية. أظهرت النتائج أن معايير جودة المياه (درجة حرارة الماء (درجة مئوية)، والأكسجين المذاب (مل/لتر)، والرقم الهيدروجيني) كانت جميعها ضمن النطاق المناسب لتربية الأسماك. وبالمقارنة مع الاستزراع الأحادي، حقق الكارب الشائع في الاستزراع متعدد الأنواع زيادةً في الوزن، وزيادةً يوميةً في الوزن، ومعدل نموٍ نوعيٍّ أفضل (2400 غرام، و13.33 غرام، و2.35 غرام، على التوالي). بالإضافة إلى ذلك، أظهر الكارب الشائع في الاستزراع متعدد الأنواع نسبة تحويل علف أعلى (1.57). علاوةً على ذلك، فإن معدل البقاء على قيد الحياة في الاستزراع متعدد الأنواع أعلى من معدل الاستزراع الأحادي. ومع ذلك، لم يُظهر مؤشر الكبد الجسدي وعامل الحالة أي تأثيراتٍ كبيرة.

الاستنتاج : وفقاً لنتائج هذه الدراسة، فإن أسماك الشبوط الشائعة التي يتم تربيتها في نظام تربية متعدد مع أسماك الشبوط الفضي وسمك الشبوط العشبي تزيد من معدلات النمو والبقاء على قيد الحياة دون التأثير على صحتها العامة.

الكلمات المفتاحية: استخدام الأعلاف، سمك الشبوط العشبي، سمك الشبوط الفضي، البقاء على قيد الحياة، زيادة الوزن.