Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(4): 1723 – 1735 (2024)
www.ejabf.journals.ekb.eg

Effect of Adding Residues of Stone Ovens Produced for Iraqi Samoon (Bread) to Diets of the Common Carp (*Cyprinus carpio* L) on Growth and Chemical Composition

Husian Njem Hameed[1]*, Rasool Hassan Khalati[1], Mrtatha K Al-Zrkania[1], Sabreen Hadi Hanash[2], Safa Jabbar Mudheher[1], Nada Mohammed Sadoon[3]

[1]Department of Animal Production, Waist University, College of Agriculture, Kut, Iraq
[2]Department of Plant Protection, College of Agriculture, Waist University, Kut, Iraq
[3]Department of Field Crops, College of Agriculture, Waist University, Kut, Iraq

***Corresponding Author: husain@uowasit.edu.iq**

ARTICLE INFO

Article History:
Received: July 11, 2024
Accepted: Aug. 15, 2024
Online: Aug. 18, 2024

Keywords:
Bread,
Samoon,
Diet fish,
Common carp

ABSTRACT

The study included adding stone oven samoon, a popular type of bread in Iraq, to carp's diets. The levels were distributed among five experimental diets, each representing a single treatment (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%). The fish were distributed across the experimental treatments in three replicates. The fish used in the study had an average weight of 10.36 ± 0.53g. They were fed on specific diets for a period of 72 days, during which the environmental changes in the tank water were monitored. The growth results of the experimental fish were recorded throughout the study. Fish from Diet 5 exhibited the highest final weight (WF) at 48.82 ± 1.61g and were statistically significant ($P \leq 0.05$). Improvement was observed in both the feed conversion ratio (FCR) at 2.40 ± 0.08 and the specific growth rate (SGR) at 2.08 ± 0.03% day^{-1}. The chemical composition of the fish bodies fed on the experimental diets was analyzed. Among the diets, Diets 5 and 4 showed significantly higher protein content in the fish bodies, with values of 73.61 ± 0.96 and 76.33 ± 1.26%, respectively, outperforming the other diets at a significance level of $P \leq 0.05$. Moreover, Diet 1 showed a statistically significant ($P \leq 0.05$) higher fat percentage at 11.96 ± 0.61. We conclude from this study that the effect of samoon has significantly influenced both the chemical composition and body growth of the study fish.

INTRODUCTION

Recently, Iraq has witnessed a development in popular restaurants, leading to an increased demand for bread. The most consumed type of bread is the samoon produced by traditional stone ovens in Iraq. At the same time, feed prices have risen due to increased fish production **(Nguyen & Kinnucan, 2018; Delgado *et al.*, 2020)**. This has prompted the search for solutions to help boost production and enhance growth to address challenges in the labor market. As a

result, efforts have been made to utilize the leftovers of the ovens, which are the remaining discarded samoon remnants.

Bread is a common product in many countries. It is made from wheat grains and is a staple food in most countries worldwide. It is prepared by mixing flour with some secondary ingredients, fermenting the dough, and baking it in the oven. Afterward, it is left to cool and dry before consumption. Wheat meets about 23.4% of the world's food needs and is a significant source of nutrition for approximately 40% of the world's population, providing around 20% of the necessary calories and protein for humans **(Mottaleb*et al.*, 2023)**. The bread industry faces challenges in many countries due to significant economic waste from the disposal of excess bread as restaurant leftovers.

The common carp (*Cyprinus carpio*) is regarded as one of the highest-quality fish, highly valued by both consumers and producers throughout the production line **(Karnai & Szűcs, 2018)** due to its attributes that qualify it to be among the priorities of the labor market. It withstands high summer temperatures, has high feed conversion efficiency, a short capital turnover cycle, delicious taste, and high immunity against diseases **(Taheri-Garavand *et al.*, 2019;Yaqoob, 2021)**. These characteristics have made it this species the foremost fish in aquaculture in Iraq and globally.

Nutrition is a crucial aspect of fish production projects, especially in operational expenses, as it constitutes 70-80% of the operational costs of medium-scale projects **(Thiao & Bunting, 2022)**. This percentage is significant in determining the cost of aquaculture project outputs. Furthermore, feed additives are important in promoting growth and ensuring production sustainability **(Górniak*et al.*, 2018; Hossain *et al.*, 2024)**.

This study aimed to address the increase in fish feed prices while tackling issues of sustainable environmental development by utilizing the waste from traditional stone ovens. Furthermore, it seeks to ensure growth promotion for fish by creating suitable and non-traditional feed alternatives.

MATERIALS AND METHODS

The fish used in the experiment

The common carp fish were used in a study with an average weight of 10.36 ± 0.53 SD. The fish were sourced from a hatchery in Kut City, Iraq. They were exposed to a 2% saline solution for 5 minutes. The experiment lasted for 72 days from 10/4/2024 to 20/6/2024. 150 fish were used in the study, with 30 fish per treatment in three replicates. The study was conducted at Waist University /College of Agriculture / Department of Animal Production / Kut / Iraq. The temperature in the study location ranged from 25 to 30°C.

The tanks used in fish culture

Five tanks were used for the study with dimensions of 30 × 30 × 70cm, each containing 42L of water. All tanks were filled with household water after undergoing various treatments. A reserve tank was used to fill the water and remove chlorine from it before transferring it to the other tanks. The tanks were sterilized with sodium hypochlorite at a concentration of 200ppm, a highly oxidizing substance used worldwide as a disinfectant and bleach **(Cheng *et al.*, 2022)**. All tanks have designated areas for filter placement, including sponges and a gravel layer to create a simple internal filtration system for each tank. These tanks were filled with water, and a small amount of food was added to complete the biological cycle in each tank, creating a suitable environment for fish growth before introducing the fish for the study. All tanks were covered with nets to prevent fish from jumping out. The lighting used came naturally from sunlight during daylight hours. The pumps used in the study were simple pumps for water circulation in each tank, also commonly used in Iraq as natural ventilation cooling pumps.

Environmental analyses

The temperature was recorded by immersing a locally sourced mercury thermometer, with a range of 0-50°C, in water for one minute. The water's salinity was checked using a portable EC meter from the Italian company, Hanna. Daily measurements of oxygen concentration were taken inside the basins using an oxygen concentration field device from the English company, Jenway. Water samples were collected daily from each basin to determine pH values and were tested using a portable EC meter from the Italian company, Hanna.

Diet of fish

Five experimental diets were formulated containing sun-dried bread residues, naturally dried by sunlight, which were mixed with manufactured experimental feed materials. Different proportions of bread residues were added to the experimental diets (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%). The protein content in the experimental diets was 28.95%. A national brand meat grinder with 1.5mm diameter orifices was used to process the feed. Subsequently, the wet feed was extruded into threads and naturally dried with continuous stirring. The feed was then cut into discs and stored in suitable bags with an information lable on each bag, and the diet was stored at a temperature of 4°C to prevent spoiling (Table 1).

Table 1. Formulations (g per 1000g) and chemical composition (%) of the experimental diets, (samoon)

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Soybean	350	350	350	350	350
Yellow corn	300	300	300	300	295
Barley	120	120	120	115	115
Wheat bran	100	100	95	95	95
Fish powder	100	95	95	95	95
Vit mineral mixture[1]	8	8	8	8	8
Corn oil	20	20	20	20	20
Antioxidant[2]	2	2	2	2	2
Samoon	0	5	10	20	30
chemical composition					
Moisture	5.79	5.04	6.74	5.15	5.79
Protein	28.1	28.8	28.2	29.13	28.95
Fat	5.2	5.8	5.3	5.2	5.3
Fiber	6.5	6.8	6.5	6.8	6.1
Carbohydrate	47.71	46.76	47.06	47.62	46.76
Ash	6.7	6.8	6.2	6.1	7.1
Energy[3]Kilocal/100g	416.3855	421.57	414.969	421.7118	417.804

[1]Each gram contains vitamins A (800 IU), vitamin D3 (1500 IU), vitamin E (1mg), vitamin B1 (0.5mg), B2 (0.5mg), B6 (0.2mg), B12 (0.008mg), folic acid (0.05mg), K3 (2mg), nicotinic acid (6mg), iron sulfate (0.5mg), manganese sulfate (0.4mg), cobalt chlorides (0.01mg), zinc sulfate (0.15mg).

[2]Butyrate Hydroxyl Anisole (BHA) type antioxidant.

[3]Total energy = % of protein x 5.56 + % of carbohydrates x 4.45 + % of fat x 9.2

Growth performance

Calculating statistical analysis for growth indicators of fish in the study experiment was based on the mathematical equations measuring fish growth.

- Weight gain (WG) g = Final weight (FW)- Initial weight (IW)
- Daily weight gain (DWG)g = Weight gain(WG)/ Time duration (days)
- Feed conversion ratio(FCR) = Feed intake (g)/ Weight gain (g)
- Feed conversion efficiency (FCE%) = Biomass(g) / Total feed intake(g)
- Protein Intake(PI) = Feed Intake (g) × Protein in diet % /100
- Protein efficiency ratio(PER) = Weight gain(g)/ Protein intake(g)

- Specific growth rate (SGR %. Day^{-1}) = 100 × [(ln final fish weight) - (ln initial fish weight)] /Time duration (days).

Statistical analysis of the study experiment

The experiments were conducted following a fully randomized design with three replications. The treatments were evaluated, and the significance of the treatments was determined using the one-way ANOVA analysis with Origin Pro 2023 software. A comparison of treatment means was then performed, and significance was assessed using the Tukey test at a significance level of $P< 0.05$, accompanied by descriptive statistics (± SD).

RESULTS

Environmental measurements

The results showed average measurements of environmental factors, as displayed in Table (2), without noticing significant differences between the means since efforts were made throughout the 72-day study period to maintain these averages to create a suitable environment for raising the common carp. The recorded temperature ranged from 24.9 to 27.7°C, oxygen levels ranged from 6.9 to 8.2mg. L^{-1}, pH ranged from 7.4 to 8.6, and salinity ranged from 1.8 to 2.5mg. L^{-1}. Furthermore, principal component analysis was conducted as shown in Fig (1), with percentage of variance (%) results indicating temperature at 1.90, oxygen at 3.79, pH at 39.69, and salinity at 54.60 mg. L^{-1}.

Table 2. The experimental treatment water's temperature rate, acid function value, dissolved oxygen concentration, and salinity value

Treatme	water temperature (	Oxygen ($mg.l^{-1}$	pH	Salinity ($mg.l^{-1}$)
Diet 1	25.9	8.2	7.9	1.8
Diet 2	26.3	7.5	8.6	2.5
Diet 3	27.7	7.6	8.6	2.5
Diet 4	25.2	7.8	7.9	1.5
Diet 5	24.9	6.9	7.4	2.4

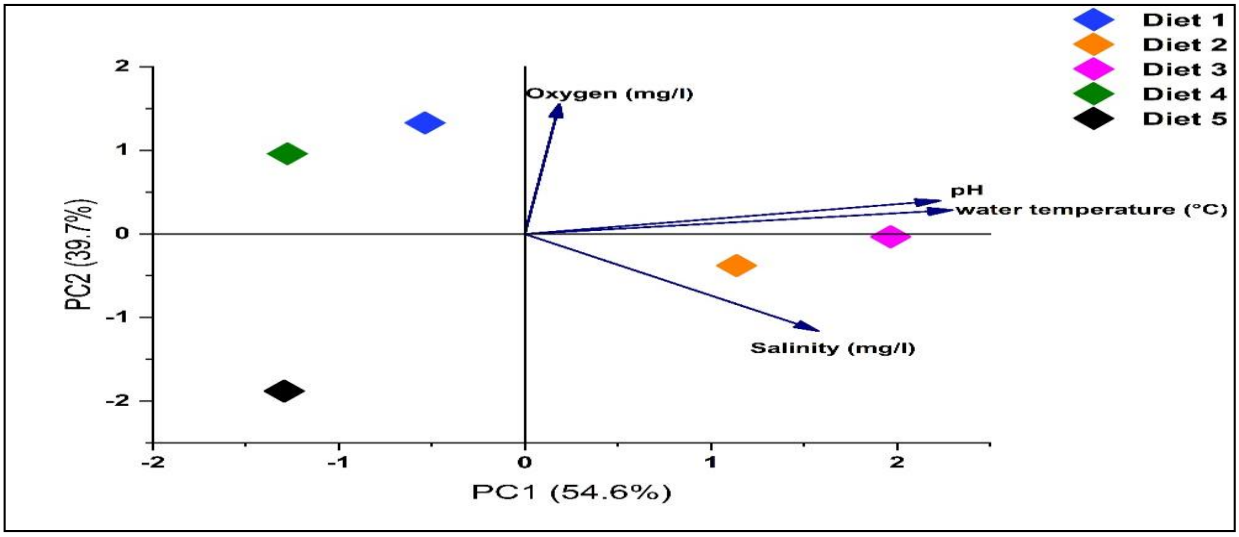

Fig. 1. The principal component analysis (PCA) of the environmental measurements in the experimental tanks. Principal component analysis is a statistical technique that simplifies complex data sets by reducing the number of variables while retaining as much of the original spread as possible. PCA works by identifying underlying patterns in the data and representing them in a new set of variables called principal components

Utilizing diets and growth

Table (3) illustrates the statistical analysis of the varying growth data for carp fed on diets with multiple levels of Iraqi samoon (Iraqi bread) waste residues from samoon production ovens. Under the Diet 5 treatment, the results for FW, WGD, FI, and PI significantly increased ($P \leq 0.05$), with the recorded values being 48.82± 1.61g for FW, 0.53± 0.02g for WGD, 91.51± 4.46g fish^{-1}for FI, and 26.49± 1.29% for PI.

Table 3. Growth of carp fed with diets containing different Iraqi samoon waste residues from samoon production ovens

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
IW g	10.03 ± 0.50	10.56 ± 0.20	9.93 ± 0.70	10.43 ± 0.15	10.83 ± 0.61
FW g	34.69 ^{b} ± 2 .04	37.74 ^{b} ± 1.54	36.21 ^{b} ± 0.49	45.54 ^{a} ± 1.33	48.82 ^{a} ± 1.61
WGD g	0.33 ^{c} ± 0.02	0.37 ^{c} ± 0.02	0.35 ^{c} ± 0.00	0.48 ^{b} ± 0.01	0.53 ^{a} ± 0.02
FI (g. fish^{-1})	70.12 ^{b} ±3.83	76.59 ^{b} ±1.93	72.08 ^{b} ±2.79	85.70 ^{a} ±0.90	91.51 ^{a} ±4.46
PI %	19.7 ^{b} ±1.07	22.05 ^{b} ±0.55	20.32 ^{b} ±0.78	24.96 ^{a} ±0.26	26.49 ^{a} ±1.29

Values are mean ± SD (n = 3). Different letters in the same row indicate significant treatment differences ($P \leq 0.05$). Treatments (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%). IW- The initial weight, FW- The final weight, WGD - daily weight gain, FI - Food intake, PI – Protein Intake.

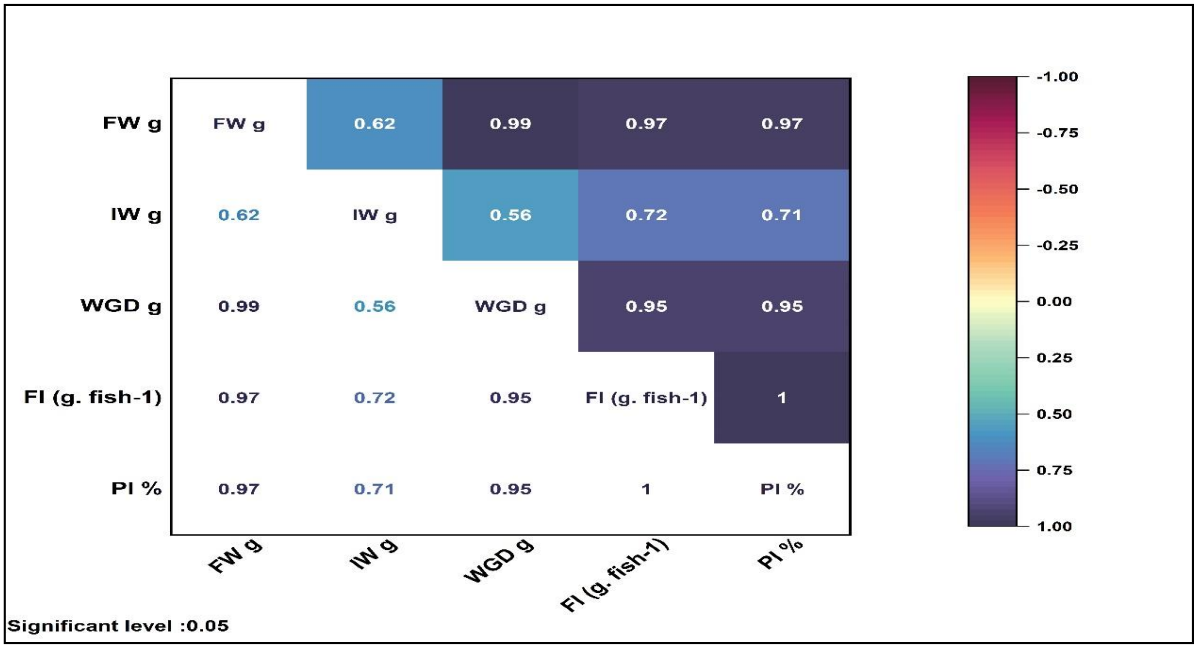

Fig. 2. Correlation analysis (Plot Correlation) of the growth of carp-fed diets consisting of varying amounts of samoon from local restaurants in Iraq.
Statistically significant results are in bold. R – Pearson correlation coefficient, P – *P*-value. IW- The initial weight, FW- The final weight, WGD - daily weight gain, FI - Food intake, PI – Protein intake

The statistical analysis of growth and feed utilization results in Fig. (3) indicates a significant difference ($P \leq 0.05$) for treatments Diet 4 and Diet 5 in terms of WG and FCR. WG values were 35.10± 1.31g and 37.99± 1.01g for Diet 4 and Diet 5, respectively, while FCR values were 2.44± 0.11 and 2.40± 0.08 for the same treatments. There were no significant differences ($P \leq 0.05$) among the remaining treatments.

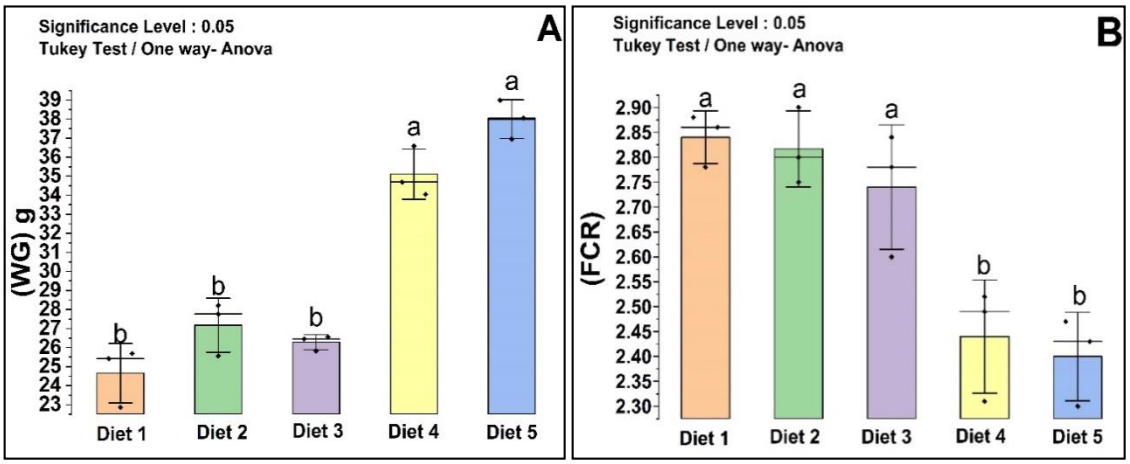

Fig. 3. (A) Weight Gain (WG) and **(B)** Feed Conversion Ratio (FCR) rates for treatments of Iraqi samoon waste (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%) Values (Mean ± SD) for the treatments are presented in the Figure. The letters above the

treatments indicate significant differences between treatments. The analysis was conducted using the Tukey Test in a one-way ANOVA design.

The statistical analysis results for growth and feed utilization are illustrated in Fig. (4). There was a significant improvement ($P \leq 0.05$) in the specific growth rate (SGR) for treatments (Diet 4 and Diet 5), recorded as 2.04 ± 0.04% day^{-1} and 2.08 ± 0.03% day^{-1}, respectively. Additionally, treatment Diet 5 showed a significant increase ($P \leq 0.05$) in protein efficiency ratio (PER), recorded as 1.43 ± 0.05, compared to the other treatments.

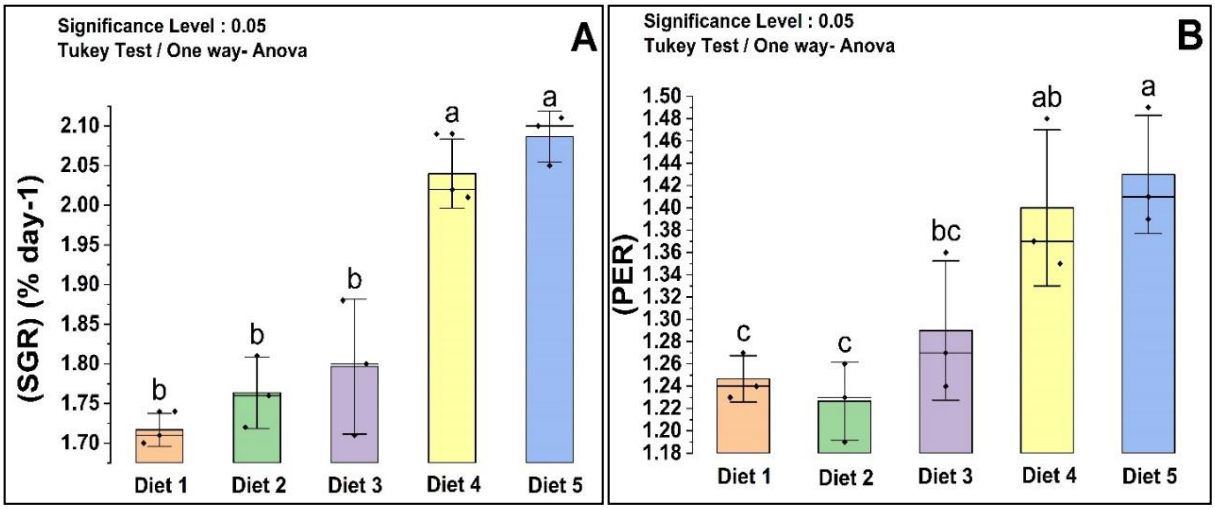

Fig. 4. (A) Specific growth rate (SGR) and **(B)** Protein efficiency ratio (PER) rates for treatments of Iraqi samoon waste (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%) Values (Mean ± SD) for the treatments are presented in the Figure. The letters above the treatments indicate significant differences between treatments. The analysis was conducted using the Tukey Test in a one-way ANOVA design

The chemical composition of fish bodies fed on experimental diets (protein, lipid)

Fig. (5) shows that the percentage of protein in the bodies of fish fed the experimental diet treatments Diet 4 and Diet 5 significantly outperformed ($P \leq 0.05$), recording 73.61 ± 0.96 and 76.33 ± 1.26%, respectively, followed significantly ($P \leq 0.05$) by treatment Diet 3, recording 70.46 ± 1.29%. For the fat percentage in fish bodies, it was significantly increased ($P \leq 0.05$) in treatment Diet 1, recording 11.96 ± 0.61% compared to the other treatments.

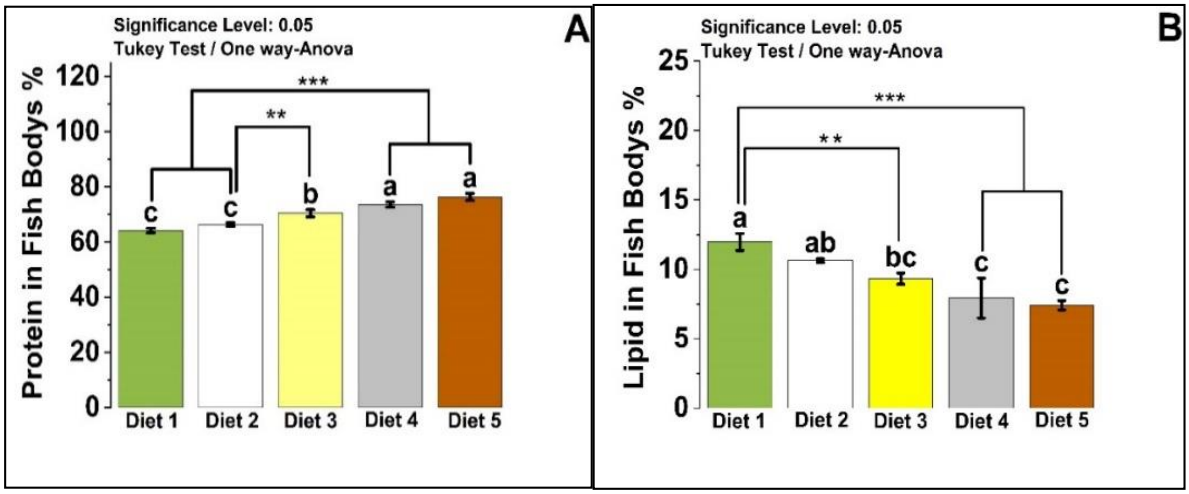

Fig. 5. (A) Raw protein percentages and **(B)** Fat percentages in the bodies of fish fed on experimental diets for treatments of Iraqi samoon waste (Diet 1 = 0%, Diet 2 = 0.5%, Diet 3 = 1%, Diet 4 = 2%, and Diet 5 = 3%) Values are presented as Mean ± SD for the treatments as shown in the Figure. The letters above the treatments indicate significant differences between treatments. The analysis was conducted using the Tukey Test in a one-way ANOVA design

DISCUSSION

Measurements of the environment

The environmental results for the water in the experimental tanks showed varying levels of environmental parameters in the current study. The water temperature in the tanks was found to be suitable for rearing THE common carp, with temperatures ranging between 20-30°C, as noted by **Paniczet *al*. (2022)**. The temperature was highlighted as having a significant impact on the growth and immunity of the fish against various diseases **(Cascarano *et al.*, 2021; Mugwanya *et al.*, 2022)**.

Furthermore, dissolved oxygen levels are crucial for the growth of the common carp to achieve the highest growth productivity, with a recommended minimum level of 5mg. L^{-1} in aquaculture tanks **(Bulbul Ali & Mishra, 2022)**. The water in the experimental tanks had appropriate and elevated dissolved oxygen levels above 5mg/ L, which is favorable for the growth and aquaculture of the fish. These findings align with those of **Ed-Idoko *et al.* (2021)**, who recorded dissolved oxygen values between 7.45 - 9.05mg. L^{-1}.

The pH value in the water of the experimental tanks fell within suitable and natural ranges for the growth of the common carp, as emphasized by **Hameed and Abid (2024)**, who elucidated that the optimal pH for rearing the common carp is 7.3 – 8.2. The salinity levels in the experimental tanks were found to be normal. **Anand*et al.* (2022)** confirmed that a salinity level of 10ppt can be tolerated by the common carp. This is consistent with the findings of **Hameed and Abid (2024)** showing a salinity level of 2.3mg. L^{-1} in the experimental tanks.

Fish growth

The growth results indicate significant ($P \leq 0.05$) differences between treatments for different growth traits of the fish under study. To our knowledge, this study is the first to document that residual bread from ovens can be used as feed additives that have contributed to a certain level of growth enhancement. This, in turn, can help reduce feed costs and assist breeders in increasing the production. This study aligns with the findings of **Hameed and Abid (2024)** upon using dry bread residues from the Iraqi restaurants as feed additives for fish at varied proportions, yielding the highest recorded growth increase at 1.5%. The study deviates from what was found in **Taher (2020)**, where the carp specimens were cultured in floating cages and fed on rations containing 75% dry bread and 25% dry fish at different densities, showing only slight significant differences in daily weight gain.

Table (3) illustrates the significant ($P \leq 0.05$) differences observed in treatment Diet 5 for growth traits such as FW, WGD, FI, PI. Adding bread residues likely contributed to growth enhancement due to its protein content **(Hama *et al.*, 2022)**, potentially maximizing the utilization of the provided feed. Furthermore, the high carbohydrate content in bread **(Fu *et al.*, 2020)** is an important energy source for fish biological activities.

As shown in Figs. (3, 4), there are significant ($P \leq 0.05$) enhancements in most growth traits for treatment Diet 5, followed by treatment Diet 4 for WG and FCR. This can be attributed to the higher feed conversion efficiency resulting from higher feed intake and the ability of these feeds to be converted into lean meat in fish bodies, enhancing digestive system function and health through the effect of beta-glucans in bread on gut microbes **(Igual *et al.*, 2021)**, possibly contributing to the production of short-chain carbon compounds that aid in the activation and movement of intestines in fish fed experimental diets.

Furthermore, the Iraqi bread is fortified with essential vitamins and minerals necessary for fish growth and development through additives during the manufacturing, preparation, and production stages in bakeries, including additions such asegg whites, yolks, or even some flavorings, known as bread fortification **(Souza *et al.*, 2022)**. This justification has led to a significant ($P \leq 0.05$) improvement in the growth traits of SGR and PER.

Analyzing the chemical composition of fish bodies

As shown in Fig.(5), the statistical results demonstrate a higher protein percentage in treatments Diet 4 and Diet 5. This may be attributed to a greater utilization of protein from the experimental diets compared to the other feeds. This indicates that the inclusion of bread in larger quantities in these feeds may had a role in enhancing the utilization of raw protein in the diet. Furthermore, samoon increases appetite and increases eating **(Kristensen*et al.*, 2009; Wang *et al.*, 2015)**,which might have led to an increased food intake, resulting in a greater protein utilization.

Regarding fat content, the results displayed a clear decrease in feeds that showed increases in protein content, which is a natural phenomenon as the body fat percentage decreases as the protein percentage increases. This is a positive indicator of the results due to the feed additives that played a clear role in achieving the appropriate and important weight gain in fish production.

CONCLUSION

The experience of the current study has had an impact on the treatment of furnace wastes, which naturally affects the application of sustainable environmental systems. Furthermore, the increasing prices of traditional animal feeds and the attempt to introduce non-traditional feeds have influenced this study in evolving current research into more extensive research through mixing samoon crumbs with restaurant wastes. Furthermore, it is concluded that adding samoon crumbs to fish diets has resulted in higher growth rates and improved fish production. Additionally, the previously mentioned enhancements were dose-dependent. This current study is deemed highly significant since bread is a staple food consumed worldwide. Nutritional additives in animal feed, particularly in the fishery sector, are of great importance. Introducing additives high in energy and carbohydrates is crucial for sustaining fish's biological and fish culture activities.

REFERENCES

Ahmed, I.;Jan, K.;Fatma, S. and Dawood, M. A. (2022). Muscle proximate composition of various food fish species and their nutritional significance: A review. *Journal of Animal Physiology and Animal Nutrition, 106*(3): 690-719. https://doi.org/10.1111/jpn.13711.

Anand, G.; Srivastava, P. P.; Varghese, T. and Gupta, S. (2022). Rearing in hypersaline inland ground saline water affect growth and osmoregulatory responses of Common carp (Linnaeus 1758). 08 March 2022, PREPRINT (Version 1) available at Research Square https://doi.org/10.21203/rs.3.rs-1164718/v1.

Bulbul Ali, A. and Mishra, A. (2022). Effects of dissolved oxygen concentration on freshwater fish: A review. International Journal of Fisheries and Aquatic Studies, 10: 113-127. https://doi.org/10.22271/fish.2022.v10.i4b.2693.

Cascarano, M. C.;Stavrakidis-Zachou, O.;Mladineo, I.; Thompson, K. D.;Papandroulakis, N.and**Katharios, P.** (2021). Mediterranean aquaculture in a changing climate: Temperature effects on pathogens and diseases of three farmed fish species. *Pathogens*, *10*(9): 1205. https://doi.org/10.3390/pathogens10091205.

Cheng, X. S.; Wang, S. N.; Huang, W. X.; Wang, F., Fang, S. Y.; Ge, R.; Zhang, Q.; Zhang, L., Du, W.; Fang, F.; Feng, Q.; Cao, J. S. and Luo, J. Y. (2022). Current

status of hypochlorite technology on the wastewater treatment and sludge disposal: Performance, principals, and prospects. Science of the Total Environment, 803: 20. http//dx.doi.org/10.1016/j.scitotenv.2021.150085.

Delgado, C. L.; Wada, N.; Rosegrant, M. W.; Meijer, S. and Ahmed, M. (2003, October). Outlook for fish to 2020. In *Meeting global demand [Internet]. International Food Policy Research Institute, Washington, DC.*

Ed-Idoko, J. O.; Solomon, S. G.; Annune, P. A.; Iber, B. T.; Torsabo, D. and Christiana, O. N. (2021). Breeding of common carp (Cyprinuscarpio) using different approaches. *Asian Journal of Biology*, *12*(3): 42-49. https://doi.org/10.9734/AJOB/2021/v12i330166.

Fu, L.; Wu, J.;Yang, S.; Jin, Y.; Liu, J.; Yang, M. and Xiao, Y. (2020). Genome-wide association analysis of stem water-soluble carbohydrate content in bread wheat. *Theoretical and Applied Genetics*, *133*: 2897-2914. https://doi.org/10.1007/s00122-020-03640-x.

Górniak, W.; Cholewińska, P. and Konkol, D. (2018). Feed additives produced on the basis of organic forms of micronutrients as a means of biofortification of food of animal origin. *Journal of Chemistry*, *2018*(1): 8084127. https://doi.org/10.1155/2018/8084127.

Hama, A. A.; Weli, S. M.; Salih, S. M.; Feaq, A. B. and Ali, F. M. (2022). Determination of Potassium Bromate in Bread Brands in Sulaimani City, Kurdistan-Iraq. *UHD Journal of Science and Technology*, *6*(1):76–79. https://doi.org/10.21928/uhdjst.v6n1y2022.pp76-79.

Hameed, and Abid, S. (2024). Effect of Adding Leftover Bread to Iraqi Restaurant Waste on the Common Carp (Cyprinuscarpio) Diets and its Impact on Growth and Chemical Composition. *Egyptian Journal of Aquatic Biology and Fisheries*, 28(3):709-721 https://doi /10.21608/EJABF.2024.360516.

Hossain, M. S.; Small, B. C.; Kumar, V. and **Hardy, R**. (2024). Utilization of functional feed additives to produce cost-effective, ecofriendly aquafeeds high in plant-based ingredients. *Reviews in Aquaculture*, *16*(1): 121-153. https://doi.org/10.1111/raq.12824.

Igual, M.; García-Segovia, P. and Martínez-Monzó, J. (2021). Amino acids release from enriched bread with edible insect or pea protein during in vitro gastrointestinal digestion. *International Journal of Gastronomy and Food Science*, *24*, 100351. https://doi.org/10.1016/j.ijgfs.2021.100351.

Karnai, L. and Szűcs, I. (2018). Outlooks and perspectives of the common carp production. *Roczniki (Annals)*: *2018*(1). http://dx.doi.org/10.22004/ag.econ.293551.

Kristensen, M.; Jensen, M. G.; Riboldi, G.; Petronio, M., Bügel, S.; Toubro, S.; Tetens, I. and Astrup, A. (2010). Wholegrain vs. refined wheat bread and pasta. Effect on

postprandial glycemia, appetite, and subsequent ad libitum energy intake in young healthy adults. *Appetite*, *54*(1): 163–169. https://doi.org/10.1016/j.appet.2009.10.003.

Mottaleb, K. A.; Kruseman, G.; Frija, A.; Sonder, K. and Lopez-Ridaura, S. (2023). Projecting wheat demand in China and India for 2030 and 2050: Implications for food security. *Frontiers in Nutrition*, *9*, 1077443. https://doi.org/10.3389/fnut.2022.1077443.

Mugwanya, M.; Dawood, M. A.; Kimera, F. and Sewilam, H. (2022). Anthropogenic temperature fluctuations and their effect on aquaculture: A comprehensive review. *Aquaculture and Fisheries*, *7*(3):223-243. https://doi.org/10.1016/j.aaf.2021.12.005.

Nguyen, L. and Kinnucan, H. W. (2018). Effects of income and population growth on fish price and welfare. *Aquaculture Economics & Management*, *22*(2): 244-263. https://doi.org/10.1080/13657305.2017.1356397.

Panicz, R.; Całka, B.; Cubillo, A.; Ferreira, JG.; Guilder, J.; Kay, S.; Kennerley, A.; Lopes, A.; Lencart, E Silva, J.; Taylor, N.; Eljasik, P.; Sadowski, J.; Hofsoe-Oppermann, P. and Keszka S..(2022). Impact of climate-driven temperature increase on inland aquaculture: Application to land-based production of common carp (Cyprinuscarpio L.). TransboundEmergDisSep;69(5):e2341-e2350. doi: 10.1111/tbed.14577. Epub 2022 May 10. PMID: 35488872.

ShabeenaYaqoob. (2021). A Review of Structure, Origin, Purpose & Impact of Common Carp (Cyprinus carpio) in India. *Annals of the Romanian Society for Cell Biology*, *25*(6): 34–47. Retrieved from http://www.annalsofrscb.ro/index.php/journal/article/view/5156.

Souza, S. V.;Borges, N. and Vieira, E. F. (2022). Vitamin d - fortified bread: Systematic review of fortification approaches and clinical studies. *Food chemistry*, *372*: 131325. https://doi.org/10.1016/j.foodchem.2021.131325.

Taheri-Garavand, A.; Fatahi, S.; Banan, A. and Makino, Y. (2019). Real-time nondestructive monitoring of Common Carp Fish freshness using robust vision-based intelligent modeling approaches. *Computers and Electronics in Agriculture*, *159*: 16-27. https://doi.org/10.1016/j.compag.2019.02.023.

Thiao, D. and Bunting, S. W. (2022). *Socio-economic and biological impacts of the fish-based feed industry for sub Saharan Africa* (Vol. 1236). Food & Agriculture Org. https://doi.org/10.4060/cb7990en.

Wang, S.; Yang, L.; Lu, J. and Mu, Y. (2015). High-protein breakfast promotes weight loss by suppressing subsequent food intake and regulating appetite hormones in obese Chinese adolescents. *Hormone research in paediatrics*, *83*(1): 19–25. https://doi.org/10.1159/000362168.