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THE EFFECT OF USING DIFFERENT RATIOS OF FISH BY-PRODUCTS (INTERNAL ORGANS) ADDED TO THE STOMACH POWDER ON SOME FEED EVALUATION CRITERIA AND PROTEIN FOR COMMON CARP *(CYPRINUS CARPIO L.)*

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ABSTRACT

This study was conducted in the fish hatchery of Al-Suwayrah/ Department of Animal Resources/ Wasit/ Al-Suwayrah district, Iraq. 200 common carp fish with an initial average weight of 52 ± 0.00 grams per fish were fed on four experimental diets with two replicates each. The results showed that treatment T2 outperformed, followed by treatments T3 and T4, compared to the control treatment. The reason for the superiority of the second treatment may be attributed to the presence of a (33%) ratio of fish by-product powder, indicating the potential for replacing animal protein powder with fish by-product powder, along with 25% of stomach powder. This enhanced the nutritional value of the treatment, and the fish accepted the feed, which may be well-balanced in essential amino acids content. Based on the above-mentioned results, it is now possible to use stomach powder and fish by-products (internal organs) at a ratio of 33% as a partial substitute for animal protein in the diets of common carp fish in Iraq.

Keywords: Feed conversion, efficiency, fish offal, Common carp fish.

تأثير استعمال نسب مختلفة من مخلفات الأسماك (الاحشاء الداخلية) المضافة الى مسحوق الكرش في بعض معايير تقيم العليقة والبروتين لأسماك الكارب الشائع *(Cprinus carpio L.)*

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الخلاصة

أجريت هذه الدراسة في مفقس اسماك الصويرة/ دائرة الثروة الحيوانية/ واسط/ قضاء الصويرة، اذ غذيت 200 سمكة كارب شائع بمعدل وزن ابتدائي 52 ±00غم / سمكة على اربع علائق تجريبية بواقع مكررين. أظهرت النتائج تفوق المعاملة T2 ثم تلتها المعاملة T3 وT4 على معاملة السيطرة وقد يعود السبب في تفوق المعاملة الثانية الى وجود نسبة مسحوق مخلفات الأسماك (33%) وهذا يدل على إمكانية استبدال مسحوق البروتين الحيواني بمسحوق مخلفات الأسماك مع نسبة(25%) من مسحوق الكرش والذي عزز من القيمة الغذائية للمعاملة وتقبل الأسماك للعليقة التي ربما تكون متكاملة في محتواها من الأحماض الأمينية الأساسية. اعتمادا على النتائج المذكورة في أعلاه، اصبح بالامكان إمكانية استعمال مسحوق الكرش ومخلفات الأسماك (الاحشاء الداخلية) بنسبة33% بديلا جزئيا عن البروتين الحيواني في علائق أسماك الكارب الشائع في العراق.

الكلمات المفتاحية: التحويل الغذائي، كفاءة، مخلفات الاسماك، اسماك الكارب الشائع.

INTRODUCTION

Fish meat is of high nutritional importance because it is rich in nutrients, vitamins and minerals, the consumption of fish meat has increased in the world in recent years due to the increasing awareness of societies and the trend towards healthy food **(Al-Khshali, 2019**). and fish is one of the cheapest species of meat compared to other meats because it is available from natural fisheries as it lies its costs in fishing and marketing operations **(Al-Sadoon& Al-Khashali**,**2015**) .wherefore Fish nutrition plays a crucial role in aquaculture as it directly affects production costs through its impact on fish growth **(Kadhim & Al-Khshali, 2020).** Several studies have explored the use of available feed materials as alternatives or additives in fish nutrition. Animal by-products, including fish offal, are considered important sources for producing high-value nutritional products using modern and advanced techniques **(Al-Ash'ab & El-Shawi, 2011)**. Researchers have been motivated to conduct further research and experiments on converting and recycling secondary products into usable products. Stomach powder is one of the digestive system by-products of animals **(Chalamiah *et al*., 2012)**. The chemical composition of stomach powder is similar to that of meat, but its nutritional value is lower due to its lower content of long collagen and elastin fibers, which reduce digestibility, as well as fat content **(Abdilova *et al.*, 2021).** Human consumption of fish meat results in a significant amount of waste, including skin, heads, intestines, and bones. Approximately 40% of fish meat is consumed by humans, while the remaining 60% is discarded as waste. The estimated quantity of fish waste is around 25% of the annual global fish catch, totaling more than 221,000 tons. The increasing proportion of fish waste from these catches has led to the development of innovative and diverse techniques for utilization, processing, and recycling, either for human consumption, medical purposes, fertilizer production, or animal feed **(He *et al*., 2013).** Fish are a rich source of essential nutrients, including proteins, fats, fat-soluble vitamins (A, K, D), and minerals **(Mohammed &Al-Khshali, 2023).** They also have a higher protein content in their meat compared to other animals **(Mahmoud & Al-Khshali, 2022).** Fish are a good source of nutrition for many populations **(Al-Hilali & Al-Khshali, 2019).** The increasing demand for marine and freshwater products is due to the continuous growth of the world's population, as they provide healthy food products with good-quality protein **(Abimorad &Carneiro, 2007).** These products are rich in essential amino acids, unsaturated fatty acids essential for human consumption, as well as vitamins and minerals **(Fadhil *et al*., 2017).** Feed efficiency varies, with some feeds having high growth efficiency but being expensive due to the difficulty of obtaining certain ingredients that are scarce in local markets or subject to international price fluctuations, resulting in reduced profits. Animal sources are used as protein sources because they have a better nutritional value compared to plant sources, which may contain anti-nutritional factors and have negative effects on the digestive system and metabolic activity. Some of these sources may contain toxins, in addition to the limited availability of some essential amino acids and high fiber content in some, as well as low digestibility **(Abdel-Tawwab & Monier, 2018)**.

MATERIALS AND METHODS

The experiment was conducted at the Al-Suwayrah fish hatchery, Department of Animal Resources, Wasit, Al-Suwayrah district. 200 fingerlings of common carp fish (Cyprinus carpio L.) were obtained from fish farms located in the eastern Al-Rahmaniya area, a part of the Al-Suwayrah district in Wasit province, and they were transported using a specialized transport vehicle equipped with a pump for water circulation and aeration. Each fingerling weighed 52 ± 0.00 grams and was placed in special resting tanks. Afterward, they were transferred to prepared containers and placed in the lake for acclimatization for 15 days. The containers were sterilized with a saline solution of 5 grams per liter to eliminate external parasites, if present. The fish were randomly distributed among the containers.Twenty-five fish with an initial weight of 52 ± 0.00 grams were placed in each container, with two containers per treatment. The fish were fed three meals a day (8 AM, 12 PM, and 4 PM) with a feed ratio of 7%. The experiment lasted for 70 days, and the fish were weighed every 15 days using a Chinese electronic scale.

Experimental Diets: Four experimental diets were prepared as described in the table below.

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Table (1): Components of Experimental Diets.

Feed Ingredients:	**%T1 Control Diet: Contains 50% animal protein and 50% stomach powder and is free from cooked and dried fish by-product powder.**	**%T2 Contains 33.3% animal protein, 50% stomach powder, and 16.7% cooked and dried fish by-product powder as a partial substitute for animal protein.**	**%T3 Contains 16.7% animal protein, 50% stomach powder, and 33.3% cooked and dried fish by-product powder as a partial substitute for animal protein.**	**%T4 Contains 50% stomach powder and 50% cooked and dried fish by-product.**
Fish Powder	5	5	5	5
Animal Protein Concentrate	12.5	8.375	4.25	0
Cooked and Dried Fish By-Product:	0	4.125	8.25	12.5
Dried Stomach Powder:	12.5	12.5	12.5	12.5
Soybean Meal	35	35	35	35
Yellow Corn:	8	8	8	8
White Barley	6	6	6	6
Dried Brewer's Yeast	5	5	5	5
Fine Bran	5	5	5	5
Local Flour	8	8	8	8
Fish Oil	1	1	1	1
Vitamins and Minerals	1	1	1	1
Salt:	1	1	1	1
Total	100	100	100	100
Protein (%)	33.68	38.5	37.53	36.09

1- Feed Conversion Ratio (FCR): This is a measure of feed efficiency and represents the amount of feed provided to fish (in grams per fish) divided by the wet weight gain of the fish (in grams per fish). It is an indicator of how efficiently fish convert feed into body weight gain. **(Al-Zuhairi & Al-Shawi, 2020)**

$$\textbf{Feed Conversion Ratio (FCR)} = \frac{\text{The amount of food provided to the fish (grams per fish)}}{\text{Wet weight gain of the fish (grams per fish)}}$$

2- Feed Conversion Efficiency (FCE) (%): This is the inverse of the Feed Conversion Ratio (FCR) and is expressed as a percentage. It is calculated according to the equation referenced by **(McCormick *et al.*, 1989).**

$$\textbf{Feed Conversion Efficiency (FCE)} = \frac{\text{Wet weight gain of the fish (grams per fish)}}{\text{The amount of food provided to the fish (grams per fish)}}$$

Amount of Protein Consumed (PI): It is calculated according to the equation mentioned by **(Gerking, 1971).**

$$\textbf{The amount of consumed protein} = \frac{\text{PI} = \text{Amount of Food Provided} \times \text{Feed Protein Percentage}}{100}$$

3- Protein Efficiency Ratio (PER): It is one of the indicators used to estimate weight gain per unit of protein consumed in the diet and is calculated according to the equation mentioned by **(Gerking., 1971).**

$$\textbf{Protein Efficiency Ratio (PER)} = \frac{\text{Total weight gain (grams)}}{\text{Amount of provided protein}}$$

Protein Production Value (PPV): It represents the percentage of protein deposited in the body relative to the protein consumed in the diet and is calculated using the equation as mentioned by**. (Halver & Hardy, 2002).**

$$\textbf{Protein Production Value (PPV)} = \frac{\text{End of trial body protein (\%)} - \text{Beginning of trial body protein (\%)}}{\text{Provided food protein (grams)}} \times 100$$

5- Net Protein Utilization (NPU): Calculated according to what (Jasim, 2022) mentioned**.**

$$\text{Net Protein Utilization (NPU)} = \frac{\text{Body protein at the end of the trial (\%)} - \text{Body protein at the beginning of the trial (\%)}}{\text{Food protein} \times \text{Protein Digestibility Coefficient}} \times 100$$

Calculating the Consumed Feed Quantity: This experiment was conducted to determine the appropriate food quantity for the fish based on the best percentage of live body weight. The fish were starved for one day, and then they were gradually fed until satiety for 2-3 hours. Afterward, the remaining feed at the bottom of the tank was collected, placed in plastic containers, and dried under the sun. The weight of the remaining feed was measured, and it

was subtracted from the provided feed quantity to obtain the consumed feed quantity, as described in the method **(Jasim &Al-Obaidi, 2022**).

Statistical Analysis: The data was statistically analyzed using the Statistical Analysis System (**SAS, 2018**) software, following the Complete Randomized Design (CRD) for analyzing the results. Significant differences between the means of the studied traits were tested using Duncan's Multiple Range Test at a significance level of ($p \leq 0.05$), based on the following mathematical model:

$Yij = M + Ti + \sigma ij$

Where:

- Yij = Observation value j associated with treatment effect i.
- Ti = Treatment effect on the studied trait.
- M = Overall mean of the studied trait.
- σij = Random error.

Results and Discussion: Through the statistical analysis of some feed evaluation criteria, such as feed quantity, consumed protein, and the efficiency of nutrient conversion (Table 1), it is evident that Treatment T2 and T1 outperformed the other treatments, followed by Treatment T3 and T4. Although the feed quantity consumed in T2 and T1 is better than in T3 and T4, the consumed protein quantity is higher in Treatments T2, T3, and T4 than in the control treatment. This could be attributed to the protein quality derived from the digestion of fish waste, which may be superior to animal protein, complemented by its content of essential amino acids.**(He *et al.*, 2013)** highlighted that the balance of essential amino acids in fish diets plays a significant role in fish growth **(Signor *et al.*,2017)** pointed out that having different protein sources and appropriate amounts of amino acids in feeds increases fish production, as fish cannot build protein in their bodies without amino acids, which are the basic building blocks of protein**.(Toyub *et al.*, 2010)** emphasized that protein-rich food meets growth requirements. This suggests that increasing protein consumption enhances growth and weight gain. The superiority of Treatment T2 in terms of protein percentage and feed conversion efficiency could be attributed to the better palatability of the feed or the composition of the feed, containing essential amino acids necessary for growth requirements. Additionally, reaching the appropriate ratio of fish waste powder, krill powder, and animal protein concentrate in the feed complements each other, contributing to a more balanced nutrient profile, increasing the rate of feed consumption, and subsequently enhancing fish growth and improving feed conversion efficiency. These results align with**(Cahu & Infante ,2001),** who stated that fish growth and feed conversion efficiency are closely related to feed quality and its components, especially protein concentrate, as feed quality and its nutritional value determine how much is converted into flesh.

Table (1): Comprehensive Feed Evaluation Criteria for Common Carp Fed on Different Ratios of Fish Waste Powder(Mean ± Standard Error).

Parameters	Amount of Feed Consumed (g/fish)	Amount of Protein Consumed (g/fish)	Feed Conversion Ratio (FCR) -	Feed Conversion Efficiency (FCE) (%)
T1 0	3.02±220.27 A	1.02±74.19 A	0.48±5.78 a	1.46±17.42 a
T2 % 33	2.21±223.94 A	0.85±86.22 A	0.17±5.39 a	0.59±18.57 a
T3 %66	1.79±216.60 A	0.67±81.29 B	0.69±6.72 a	1.55±15.03 a
T4 % 99	0.46±215.84 A	0.17±77.90 C	0.44±6.29 a	1.12±15.98 a
Significance level	N.S	*	N.S	N.S

The means with different letters within the same column differ significantly ($P \geq 0.05$) from each other.

The results of the statistical analysis of the traits indicated that the protein efficiency ratio and the produced protein value and net protein utilization in Table (2) showed the superiority of treatments T1 and T2 for the protein efficiency ratio, reaching (0.51) %and (0.48)% respectively. They were followed by treatments T4 and T3, which reached (0.44) and (0.40) respectively. However, in terms of the produced protein value and net protein utilization, treatment T1 outperformed by (14.94)% and (0.17) %respectively, followed by treatment T2 with a percentage of (12.53)% and (0.14) respectively. Then, T3 with a percentage of (10.86)% and (0.12) respectively, and finally, T4 with a percentage of (10.66)% and (0.12) respectively. The reason for the superiority of treatments T1 and T2 may be attributed to the quality and efficiency of the nutritional elements in the feed due to the presence of this proportion of dried shrimp powder, which improved the digestion process. The digestion process helped make the protein available for fish by facilitating its digestion and breakdown, thereby increasing the protein efficiency ratio, which is a good indicator of feed efficiency or the efficiency of the feed source in promoting fish growth**. (Li *et al.* ,2013)** mentioned that the protein efficiency ratio can increase with an increase in the amount of food consumed by fish to satiety. It is worth noting that this criterion does not take into account the accumulation of fat in fish tissues, which may have an impact on weight gain rates, but it appears that all the protein in the feed is used for building new tissues, and some of it is used for maintenance.(Michael ,2008) pointed out that fish feeds should contain adequate levels of protein and should be balanced in their content of amino acids, vitamins, and minerals, which is reflected in the traits of the produced protein value and net protein utilization.**(Food Agriculture Organization, 2013)** mentioned that fish feeds should meet the needs of growth and muscle building, which is reflected in the fish of this treatment**.(Diemer e*t al.*, 2014)** stated that fish feeds should contain all the essential amino acids for protein building. The reason for the decrease in the value of produced protein and net protein utilization is due to the variation in the quantity of fat in the

feed, which led to the fish being satiated with the feed."Please note that scientific and technical translations can be complex, and the accuracy of the translation can be influenced by the specific terminology and context of the original text.

Table (2): Evaluation Criteria for Fish Feed Protein for Common Carp Fed on Different Ratios of Fish Waste Powder (Mean ± Standard Error).

Parameters	Net Protein Utilization (NPU)	Produced Protein Value (%)	NPUProtein Efficiency Ratio (PER)
T1 0	0.04±0.51 a	0.95± 14.94 A	0.01±0.17 A
T2 %33	0.01±0.48 a	0.32±12.53 Ab	0.00±0.14 B
T3 %66	0.04±0.40 a	0.88±10.86 B	0.01±0.12 B
T4 %99	0.03±0.44 a	0.64±10.66 B	0.00±0.12 B
significance level	N.S	*	*

The means with different letters within the same column differ significantly ($P \geq 0.05$) from each other."

CONCLUSION AND RECOMMENDATIONS

CONCLUSIONS

1- Fish waste powder (internal viscera) can be used in proportions of 33, 66 and 99% in common carp diets, and 33% is the best in terms of growth standards and feed evaluation criteria.

2-Use dried fish waste (internal viscera) powder at a rate of 16.7%, with tripe powder at a rate of 50%, and with animal protein powder at a rate of 33.3%. These proportions can be adopted as an alternative mixture for animal protein with local manufacture, to contribute to reducing the costs of feed protein and thus the costs of the feed itself compared to protein. The importer.

3-An inexpensive local protein concentrate can be produced from abandoned and neglected fish waste (internal viscera.(

4-Contributing to creating a clean environment by using fish waste and converting it into a useful product, which is one of the goals of sustainable development.

-Recommendations:

1-Using fish waste powder (internal viscera) and dried tripe powder as a source of animal protein in common carp diets due to its high nutritional value.

2-Encouraging feed producers to take advantage of discarded fish waste in Allawi by selling the fish and using it as a locally available and inexpensive feed material for feeding fish and reducing environmental pollution.

3- Adopting research as a way to get rid of pollution resulting from throwing fish waste (internal viscera) in Allawi, selling fish, as well as waste from slaughterhouses of large animals, by converting them into products with high nutritional value and great benefit in providing a source of animal protein for the Iraqi individual.

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