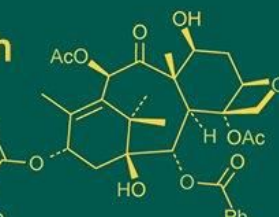
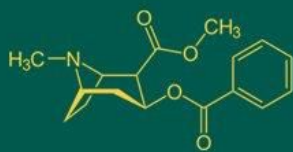


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 IJABR 2025; 9(2): 31-36
www.biochemjournal.com
 Received: 05-12-2024
 Accepted: 08-01-2025

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Effect of adding palm pollen extract to the diet of common carp (*Cyprinus carpio* L.) to achieve sustainable aquaculture

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DOI: <https://doi.org/10.33545/26174693.2025.v9.i2a.3720>

Abstract

The study was conducted to investigate the effect of adding palm pollen to the diet of common carp (*Cyprinus carpio* L.). One hundred and twenty fingerlings with an average weight of 18 ± 2 g were used, distributed across four treatments: the first group as the control, the second involved adding palm pollen at a rate of 10 g/kg, the third at 20 g/kg, and the fourth at 30 g/kg, with three replicates per treatment, each containing 10 fingerlings. The fish were reared for 75 days in glass tanks equipped with oxygen pumps, and the fish were weighed every 15 days.

The study observed a significant increase in the total weight gain rates between the experimental treatments and the control group. The experimental treatments showed a significant improvement over the control group in daily weight gain, though no differences were noted among the different addition treatments. There was also a significant improvement in the specific growth rate (SGR) and relative growth rate (RGR) between the experimental treatments and the control group. The control group recorded the highest feed conversion ratio (FCR) compared to the addition treatments. The T4 treatment recorded the highest value and significantly outperformed the control in feed conversion efficiency (FCE). The addition treatments also significantly outperformed the control in protein efficiency ratio and body protein percentage, with no differences observed in protein productive value (PPV) and moisture and carbohydrate content in the fish body.

Based on the current study's findings, it is possible to conclude that using palm pollen powder as a feed addition increased fish growth parameter, feed conversion efficiency, and chemical composition.

Keywords: Palm pollen extract, common carp (*Cyprinus carpio* L.), sustainable aquaculture, diet of common carp

Introduction

Agricultural by-products have become one of the most important components of aquaculture feed in recent years as humans and the food industry compete for conventional components (Masoudi *et al.*, 2010) [17]. To establish sustainable aquaculture, new feed ingredient sources, such as cheaper plant materials, must be introduced to provide stable aquatic feeds (Higgs *et al.*, 1995) [13]. In this context, most fish farmers worldwide must develop suitable and complementary complete diet systems using locally available materials, particularly plant by-products, due to the high cost and limited availability of fish meal and other expensive feed materials (Oberikorang *et al.*, 2015) [19].

Date palm products, among other agricultural byproducts, are one of the world's oldest food-producing plants and have traditionally played an essential part in the economy and social life. Date palm waste is utilized in the making of feed, among other diverse purposes, such as using palm fronds in handicrafts, among many other benefits. The environmental challenge faced by researchers is to find a new valuable use for these by-products (Gaber *et al.*, 2014) [9]. According to the nutritional value of palm products, Date fruits contain a lot of energy, carbs, fiber, ash, protein, and lipids in different quantities depending on the variety. Furthermore, there is palm pollen, which is rich in nutrients (Habib and Ibrahim, 2009; Abdulfeg *et al.*, 2013; Al-Hafedh and Alam, 2013) [11, 2, 3].

Date palms produce pollen, which is considered the male reproductive cells. It has been used as a medicinal treatment in ancient times and was called the "Fountain of Youth." Numerous studies have shown that it has multiple therapeutic benefits.

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It is rich in protein, which is essential for building muscles and tissues, and it contains vitamins and minerals necessary for body health. It also includes fibers that improve digestion and provides a good source of energy due to its high carbohydrate content. In addition to all this, it contains antioxidants and healthy fats (Salhi et.al., 2024) [24].

One of the most significant fish species raised for aquaculture worldwide is the common carp (*Cyprinus carpio*). According to Rahman (2015) [21], this fish is the third most introduced species globally. Around 3,500,000 metric tons of common carp were produced worldwide in 2014 (FAO, 2014) [8]. Carp is an omnivorous species and is considered a scavenger fish, preying on plankton, snails, and organic detritus in natural settings. Compared to carnivorous species, carp's digestive systems adjust to a diet higher in carbohydrates (Maraz, 2011) [18]. Common carp farming relies on the use of affordable feed ingredients and locally accessible agricultural waste products to be both successful and profitable. Using local protein byproducts properly can lower feed costs and improve economic and environmental sustainability. Therefore, by lowering expenses, creating less expensive diets with locally accessible ingredients—particularly sources of protein or carbohydrates—can have a big impact on common carp farming (Azaza et al., 2009) [5]. Date palm products, such as dates and their residues, have been shown in numerous studies to be beneficial as feed ingredients for a variety of fish species, including common carp (Hoseinifar et al., 2015; Hoseinifar et al., 2017) [14, 15], African catfish (Sotolu et al., 2014) [28], and tilapia (Bilal, 2008; Azaza et al., 2009; Gaber et al., 2014) [6, 5, 9]. The effects of supplementing common carp diets with palm pollen, however, have not been proven. Thus, the purpose of the current study is to assess how palm pollen affects the growth rates, feed intake rates, and chemical composition of common carp fingerlings.

Material and methods

- Utilized in the current experiment 120 common carp fingerlings with an average weight of 18 ± 2 grams were employed and separated into four treatments. As the control group, the first treatment had three replicates, each containing ten fingerlings. Ten grams of palm pollen powder per kilogram of feed was added in the second treatment; twenty grams of palm pollen extract per kilogram of feed was added in the third; and thirty grams of palm pollen extract per kilogram of feed was added in the fourth. Ten common carp fingerlings were used in each of the three replicates for each treatment. The fish were reared for 75 days in glass tanks, each with a capacity of 60 liters of water and equipped with oxygen pumps for the duration of the experiment. The fish were weighed every 15 days, and growth data and feed intake measurements were recorded.
- Growth parameters were calculated as follows:
 - T.W.G. (Total Weight Gain) = Final Weight - Initial Weight

- D.W.G. (Daily Weight Gain) = $(W_2 - W_1) / (T_2 - T_1)$ (Schmalhausen, 1926) [26]
 - SGR (Specific Growth Rate) = $(\ln W_2 - \ln W_1) / (T_2 - T_1) * 100$ (Brown, 1957) [17].
 - RGR (Relative Growth Rate) = $(\text{Final Weight} - \text{Initial Weight}) / \text{Initial Weight} * 100$
 - FCR (Feed Conversion Ratio) = $\text{Feed Intake (g)} / \text{Weight Gain (g)}$
 - FCE (Feed Conversion Efficiency) = $\text{Weight Gain (g)} / \text{Feed Intake (g)} * 100$ (Utne, 1978) [30]
 - PER (Protein Efficiency Ratio) = $\text{Weight Gain (g)} / \text{Protein Intake (g)} * 100$
 - PPV (Protein Productive Value) = $(\text{Body Protein at the End} - \text{Body Protein at the Beginning}) / \text{Protein Intake} * 100$ (Gerking, 1971) [10]
- Diets: The same feed ingredients were used for all treatments with the addition of palm pollen powder at rates of 1% for the second diet, 2% for the third diet, and 3% for the fourth diet, which represent the addition treatments (T2, T3, T4) as shown in Table (3).

Table 1: Shows the ingredients of the experimental diets used in the experiment

Ingredients %	T1	T2	T3	T4
Protein Premix	20	20	20	20
Soybean meal	28	28	28	28
Sesame meal	12	12	12	12
Flour	11	11	11	11
Barley	13	13	13	13
Yellow corn	14	14	14	14
Vitamins and minerals	2	2	2	2
Palm pollen powder	-	1	2	3

- The SPSS statistical analysis program was used to analyze the data according to a completely randomized design (CRD). Significant differences between means for the studied traits were tested using Duncan's multiple range test at a significance level of 0.05.

Result and Discussion

Figure (1) shows the experimental diet groups, with T4 recording the highest value (196 ± 0.01) compared to other treatments. The first and second treatments showed significant superiority over the control group, while no significant differences were observed among the addition treatments. This is attributed to the nutritional richness of palm pollen, which has a high nutritional value that improves feed utilization. These results are consistent with those of Refaie et al. (2019) [22], who found that adding pollen to poultry diets improved weight gain. The results also align with Salami et al. (2015) [23], who indicated that improved growth performance might be due to enhanced digestion enzymes and increased nutrient absorption when feeding with DPP.

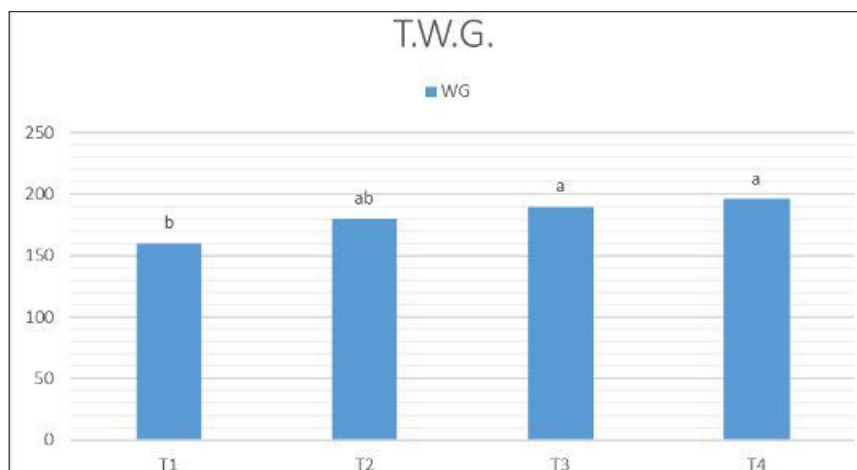


Fig 1: Shows the total weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$)

Regarding daily weight gain, there were no significant differences among the addition treatments, but they showed significant differences compared to the control group, with higher daily weight gain values than the control, as shown in Figure (2). Additionally, it was observed that weight gain

rates could be improved by adding certain substances to the diets, such as licorice, which improved growth performance and, consequently, the body weight of common carp (Al-Mafragi, 2020) [4].

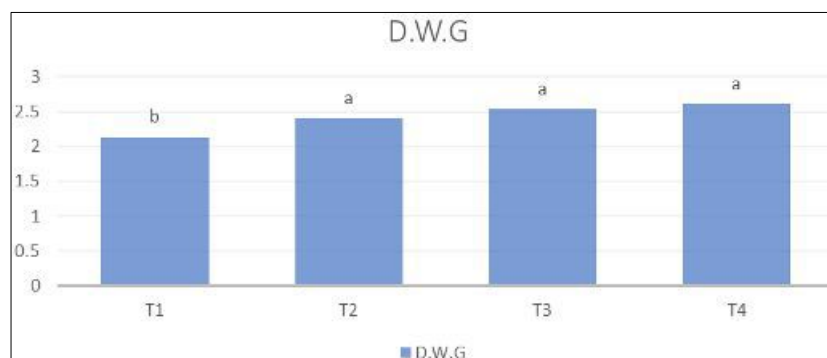


Fig 2: shows the Daily weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$)

The current experiment results indicate that the treatments with added palm pollen powder showed significant differences from the control diet in the specific growth rate (S.G.R.), which considers the weight gain rate calculated based on the duration of the experiment, as shown in Figure (4). Similar results were observed with the relative growth rate (R.G.R.) for the addition treatments (T2, T3, T4), which showed significant superiority compared to the control diet.

This is attributed to the rich nutritional content of palm pollen, which contains many essential nutrients and compounds that improve the digestive system and enhance the secretion of digestive enzymes. The results are consistent with Panettieri (2020) [20], who found that adding bee pollen to tilapia diets improved the weight gain rates of these fish as shown in Figure (4).



Fig 3: shows the total weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$)

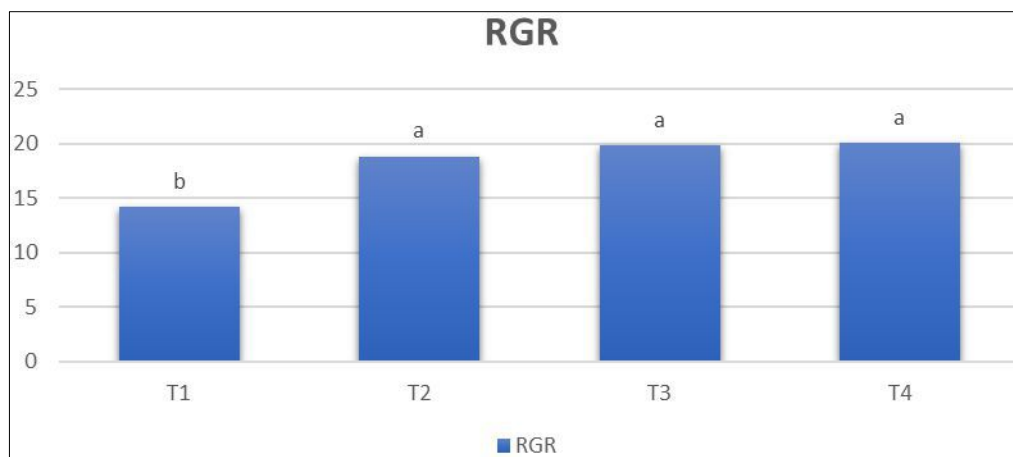


Fig 4: shows the total weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$)

As for the Feed Conversion Ratio (FCR), the lowest value was recorded in the T4 treatment, while T2 and T3 recorded lower values than the control group, as shown in Figure (5). This indicates that the addition improved feed utilization. These findings are consistent with Abdel-Tawwab (2012)^[1], who found that adding American ginseng to tilapia diets improved the FCR due to its effects on preparing the fish's digestive system and enhancing feed utilization. Significant

differences were observed in the current study between the addition treatments and the control group, with T4 showing the highest feed efficiency value, as shown in Figure (6). This is one of the main challenges in aquaculture, as feed costs represent 70% of project expenses. Therefore, finding sustainable feed sources and improving their value is crucial (Shamshak and Anderson, 2008)^[27].

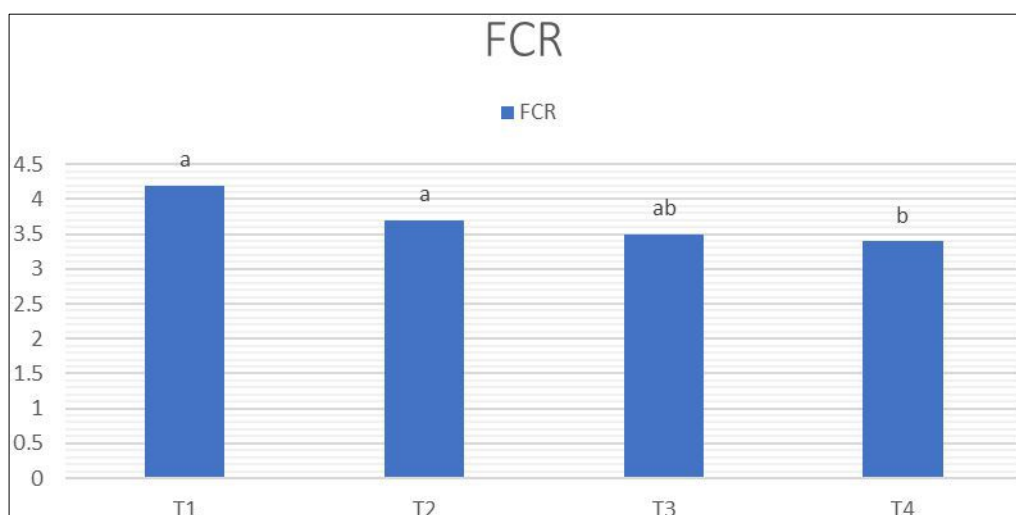


Fig 5: Shows the total weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$).

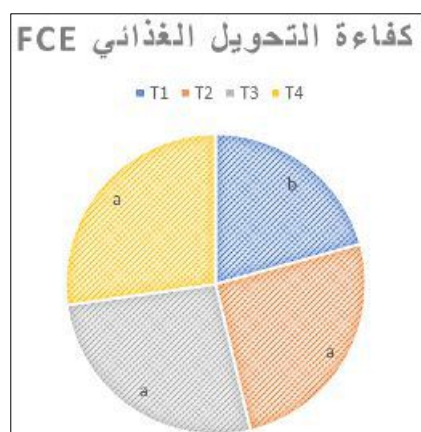


Fig 6: Shows the total weight gain of the experimental treatments. Different letters represent significant differences between treatments ($p < 0.05$).

Table (2) shows the protein efficiency ratio, with T3 and T4 showing significant differences from the control group in protein efficiency and utilization in the fish body. Protein utilization (PPV) also showed significant differences from the control group, indicating improved diet quality with the

addition of palm pollen powder. This reduces stress due to the antioxidant content, improving body condition and food utilization, thus enhancing growth performance (Jahazi, 2020)^[16].

Table 2: Shows the protein efficiency ratio and Protein Productive Value.

Treatment	PER	PPV
T1	75.79±0.38 c	4.27 ± 0.09 b
T2	94.85 ± 0.85 ab	4.43 ± 0.08 a
T3	95.34 ± 0.49 a	4.49 ± 0.03 a
T4	96.49 ± 0.29 a	4.67 ± 0.08 a

Different letters within the same column indicate significant differences ($p < 0.05$)

Table (3) shows the chemical composition of fish bodies before and after the experiment, indicating increased protein and carbohydrate percentages in fish fed diets containing palm pollen powder. These values showed significant superiority over the control group, attributed to the high

nutritional value of palm pollen and its rich content of nutrients, vitamins, and minerals, along with antioxidants that improve growth standards and overall fish growth performance due to its nutritional value (Hassan, 2011)^[12].

Table 3: shows the chemical composition of fish bodies

Treatment	Moisture	Protein	FAT	ASH	Carb.
before	75.34± 0.012 b	15.2±0.03 b	2.4± 0.012 c	6.76 ± 0.012 b	0.48± 0.01 c
after					
T ₁	72.71± 0.02 a	15.95 ± 0.02 b	3.62 ± 0.02 a	7.23 ± 0.02 a	0.53 ± 0.02 b
T ₂	73.80 ± 0.01 a	16.59 ± 0.02 a	3.51 ± 0.01 b	7.21 ± 0.01 a	0.55 ± 0.01 ab
T ₃	73.68 ± 0.03 a	16.79 ± 0.01 a	3.57 ± 0.01 ab	7.22 ± 0.01 a	0.58 ± 0.02 a
T ₄	73.95 ± 0.01 a	16.97 ± 0.01 a	3.43 ± 0.02 b	7.20 ± 0.02 a	0.57 ± 0.01 a

Different letters within the same column indicate significant differences ($p < 0.05$)

Conclusion

Adding palm pollen powder to common carp diets improved growth parameters and increased weight gain under experimental conditions. It enhanced the fish's ability to utilize feed, promoting feed sustainability in aquaculture and reducing pressure on feed materials used in industries or human nutrition. Consequently, this leads to sustainable development in production and increases the benefits of projects providing food for human consumption.

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