

**EFFECT OF MARJORAM (*MAJORANA HORTENSIS*) LEAVES
SUPPLEMENTATION ON THE GROWTH PERFORMANCE AND
BODY COMPOSITION OF COMMON CARP, *CYPRINUS
CARPIO* FRIES**

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ABSTRACT: An investigation was conducted to evaluate the effect of dietary different levels of (0, 2.5, 5 and 10 g/kg) marjoram leaves supplementation for common carp (*Cyprinus carpio*) fries. 420 fries (averaged 0.34±0.1 g) were randomly distributed into four treatments, three replicates in 12 aquaria and fed experimental diets four times per day. Results revealed that marjoram leaves as feed additives in the diets for common carp fries did affect the growth performance parameters with significant differences ($P<0.05$) among all dietary treatments. A decreasing trend was observed when the inclusion of marjoram leaves in the diets increased. Fish fed M₁ (2.5 g/kg) diet showed the best FCR and significantly differed ($P<0.05$) among all dietary treatments. No significant differences were observed in the survival of fish fed the examined diets and fish fed M₃ diet gained the highest value (96.2%). Also, significant differences ($P<0.05$) were observed in the protein content of fish body and fish fed M₃ diet gained the highest value. Also, the lipid content was similar among all treatments. However, the inclusion of marjoram leaves in the experimental diets did not significantly ($P>0.05$) affect the condition factor (K), gonadosomatic (GSI), and hepatosomatic (HSI). Moreover, significant differences ($P<0.05$) were observed in viscerasomatic (VSI) indices values among all treatments. No diet-related histopathological changes were noted in all examined tissues such as liver, intestine and gonads of common carp fries. The normality of all examined fish tissues indicated that marjoram leaves are safe to use in fish diets and can be added at 2.5 g/kg diet to improve the performance and feed utilization in the diets for common carp fries without any adverse effects.

Key words: Marjoram, common carp, diet, growth, histology

INTRODUCTION

Natural herbs have gotten a lot of attention recently, so the manufacturing of these compounds and the discovery of new natural sources of bioactive and antioxidant molecules have become key scientific and industrial endeavors (Kan *et al.*, 2008). Natural antioxidants have recently sparked renewed interest, owing to the assumption that natural food ingredients are superior to synthetic ones in terms of quality and safety (Pokorny, 1991). These plants have been discovered to have antioxidant, antibacterial, and preservative characteristics that are beneficial to the food industry (Adegoke and Skura, 1994).

Medicinal plants are increasingly being used as a natural feed supplement in fish diets, rather as traditional chemicals, which may have a cumulative effect on human health and they can be utilized as feed attractant to improve the performance and feed utilization of fish (Korni and Khalil, 2017). Many herbs have also been utilized as growth enhancers in fish (El-Dakar *et al.*, 2007) and shrimp as spices and medicinal additions. Several investigations have shown that the supplementation of herbs plants to fish diets enhances their health and resistance, as well as their condition and growth rate (Oh *et al.*, 2022; Terzioğlu and Diler 2016). Natural substances targeted at preventing and healing diseases in aquaculture are becoming increasingly popular.

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Marjoram (*Majorana hortensis*), also known as "sweet marjoram," is a member of the Lamiaceae family and one of the most effective spices (Labiatae). It's a periodic herb that grows wild in Cyprus and the eastern Mediterranean. Egypt, Greeks and Romans countries reported by (Tainter and Grenis, 1993). The therapeutic and insecticidal properties of marjoram are widely known. The plant is also said to have anticancer (Hartweel, 1969) and antioxidant properties, antifungal (El- Ghorab *et al.*, 2004) and antibacterial characteristics (Pruthi, 1980).

Common carp, *Cyprinus carpio* is a member of the Cyprinidae. It is a hardy fish which can tolerate the low dissolved oxygen, high turbidity, contamination and/ or excess nutrients. It is the most important species of all fresh water fishes. The common carp seems to be the most widely farmed carp species in Europe (EFSA, 2008). However, it is the main farmed species worldwide, which is a major economically freshwater fish (Modanloo *et al.*, 2017).

The objectives of this study are to Examine the influences of marjoram leaves (*Majorana hortensis*) as feed additive in the diets for common carp (*Cyprinus carpio*) fries on growth performance, feed utilization, biological measurements, body composition and histology.

MATERIALS AND METHODS

The present study was carried out at the Fish laboratory in the faculty of Agriculture, Poultry and Fish epartment, Menoufia University, Egypt to examine the effects of marjoram meal supplementation as feed additive in the diets for common carp fries.

Fish and Experimental design

Common carp, *Cyprinus carpio* averaged (0.34±0.01 g) were obtained from the local farm at Kafer El-Sheck, Egypt and acclimated for one week on the laboratory conditions. 420 fries were randomly distributed in 12 aquaria. Three replicates for each treatment. The aquaria were filled with aerated fresh water. All procedures and handling of animals were conducted in

compliance with the guidelines of the Institutional Laboratory Animal Care and Use Committee, Menoufia University, Egypt. Fish from each aquarium were counted and weighed at regular intervals (two weeks) to evaluate the growth and readjust the feeding rate. Twenty percent of fish body weight were fed to every three groups of the experimental fish with one of the experimental diets and decreased gradually to 10, 8 and 6% by the end of the feeding trial. Total fish weight in each tank was determined every 2 weeks to check growth and to adjust the feeding rate. Feeding was stopped for 24 h prior to weighing. The water was constantly replaced in aquaria by continuous flow at the rate of 0.25 L/min to provide oxygen and remove any excess of soluble nitrogenous wastes. In addition, the aquaria were siphoned daily before each meal to remove fecal materials.

Formulated diets

The experimental diets were formulated to be similar in crude protein (30.6 ± 0.04%) and crude lipids (5.4 ± 0.06%) (Table 1). The marjoram leaves (*Majorana hortensis*) were purchased from a local market, dried and grounded. The formulated diets were performed (g/kg diet) as, 0 (CTRL), 2.5 (M₁), 5 (M₂) and 10 (M₃) marjoram leaves. All ingredients were first ground to small particle size. Water was added to the ingredients of each diet and the pellets were formulated by using the kitchen machine. Then dried, preserved and kept in plastic bags. The proximate composition of the experimental diets was determined as stated by A. O. A. C. (2012). Fish were fed four times a day at 9:00 a.m., 11:00, 13:00 p.m, and 15:00 p.m, 6 days a week, for 12 weeks.

Water temperature and dissolved oxygen were measured every day; ammonia and pH were measured twice a week by using digital YSI (APHA, 1995). The values of water quality parameters during the experimental period were seemingly suitable for rearing common carp. Water temperature, 26.97± 0.32°C; dissolved oxygen, 6.44 ± 0.09 mg⁻¹; pH, 7.22 ± 0.03; ammonia and 0.02±0.00 mg⁻¹.

Table (1): Ingredients and chemical composition of the experimental diets.

Ingredients (g)	Dietary group (g/kg)			
	CTRL	M ₁	M ₂	M ₃
Fish meal (65%)	100	100	100	100
Soybean (44%)	440	440	440	440
Wheat bran (10%)	130	127.5	125	120
Wheat (14%)	140	140	140	140
Yellow corn (7.5%)	130	130	130	130
Marjoram leaves	0	2.5	5	10
Vegetable oil	20	20	20	20
Dicalcium phosphate	10	10	10	10
Premix ¹	30	30	30	30
Total	1000	1000	1000	1000
Chemical analysis				
Dry matter	89.81	89.71	89.51	89.52
Crude protein	30.63	30.56	30.60	30.55
Ether extract	5.33	5.43	5.55	5.35
Ash	6.34	6.44	6.55	6.64
Crude fiber	3.71	3.61	3.51	3.62
NFE ²	53.99	53.96	53.79	53.84
GE (kcal/100g DM) ³	451.27	451.69	452.33	450.32
ME (kcal/100g DM) ⁴	369.43	369.82	370.38	368.71

¹ Premix Composition: Each 1 kg contains: vitamin A, 4,000,000 International Unit (IU); vitamin D3, 8,00,000 IU; vitamin E, 40, 000 IU; vitamin K3, 1,600 mg; vitamin B1, 4,000 mg; vitamin B2, 3,000 mg; vitamin B6, 3,800 mg; vitamin B12, 3 mg; Nicotinic acid 18000 mg; Pantothenic acid, 8000 mg; Folic acid, 800 mg; Biotin, 100 mcg; Choline chloride 120,000 mg; Iron, 8000 mg; Copper, 800 mg; Manganese, 6000 mg; Zinc, 20,000 mg; Iodine, 400 mg; Selenium, 40 mg; Vitamin C (coated), 60,000 mg; Inositol, 10,000 mg; Cobalt, 150 mg; Lysine, 10,000 mg; Methionine, 10,000 mg; Antioxidant, 25,000 mg.

² Nitrogen Free Extract (NFE) = 100 – (% Protein + % Fat + % Fiber + % Ash).

³ GE= Gross energy based on protein (5.65 kcal/g), Fat (9.45 kcal/g), and carbohydrate (4.22 kcal/g) according to (NRC, 2011).

⁴ ME (kcal/100g DM) = metabolically energy was calculated by using factors 4.5, 8.1 and 3.49 kcal/g for protein, fat and carbohydrates, respectively according to Pantha (1982).

Body composition analysis

Samples of the experimental fish by the end of the feeding trials were taken to evaluate the moisture, protein, lipids, and ash contents by using the standard methods (A. O. A. C. 2012). Six fish from each treatment were sampled for analysis. Blended samples were kept at -18°C and used exclusively for biochemical examination. The dry matter, crude protein, and crude lipids were analyzed, respectively after dryness in drying oven (105°C for 6 h), by micro kjeldahl ($N \times 6.25$), and ether extraction (by soxhlet method).

Growth performance parameters

Growth parameters, all fish were count and weighed every 2 weeks. The fish weight was measured to the nearest 0.5 g

1. Weight gain (g/fish):

Weight gain was determined as following:

Weight gain (g/ fish) = Final weight (g) - Initial weight (g).

Weight gain (%) = $100 \times [\text{Final weight (g)} - \text{Initial weight (g)}] / \text{Initial weight (g)}$

2. Specific growth rate:

Specific growth rate (SGR %/ day) was calculated using the equation:

$$\text{SGR (\%/day)} = 100 \times (\text{Ln FBW} - \text{Ln IBW}) / T$$

Where, FBW is the final fish weight at the end of the experiment; IBW is the initial weight at the start of the experiment; Ln is the natural log and T is the experiment period (Days).

3. Survival rate

Survival rate (%) was estimated using the equation:

Survival rate (%) = $100 \times (\text{no. of survived fish at the end of the experiment} \div \text{no. of survived fish at the beginning of the experiment})$.

Feed utilization parameters:

1. Feed conversion ratio (FCR):

Feed conversion ratio (FCR) was calculated according to the following equation:

FCR = Feed consumed (g) during the experimental period \div weight gain during the experimental period (g)

2. Protein efficiency ratio (PER):

Protein efficiency ratio (PER) was calculated according to the following equation:

$$\text{PER} = \text{Weight gain (g)} \div \text{Protein intake (g)}$$

Biological measurements

The length (cm) and weight (g) of four fish were measured at the end of the feeding trial to calculate the condition factor (K), the gut, gonads and liver were removed to determine (GSI), (VSI) and (HSI) as the follows:

HSI = $100 \times [\text{liver weight (g)} / \text{total body weight (g)}]$ according to (Chen *et al.*, 2020).

VSI = $100 \times [\text{viscera weight (g)} / \text{total body weight (g)}]$ according to (Adel *et al.*, 2021)

GSI = $100 \times [\text{Gonads weight (g)} / \text{total body weight (g)}]$ according to (Chen *et al.*, 2020).

K = W / L^3 fish weight (g) divided by cubic of fish length (cm) according to (Ai *et al.*, 2006)

Histological examination

For histological examination, two fish of each aquarium were sacrificed (n=6 per treatment) by

ice slurry and preserved in 10% neutral buffered formalin (Thermo Fisher, Kalamazoo, MI). The next day, fish were then washed with water the next day several times and preserved in 70% ethyl alcohol for further processing. The head and tail from each fish were cut off and the intestine, liver, kidney and testis were separately dissected. Tissues were routinely dehydrated in ethanol, equilibrated in xylene, and embedded in paraffin according to standard histological techniques. All tissues were sectioned longitudinally. Sections were cut at 4 μm , mounted on glass slides and stained routinely with hematoxylin and eosin (H&E) followed by clearing through xylene and cover slipped over Permount medium.

Statistical analysis

The variances between tested groups were examined by one-way ANOVA test. Before the ANOVA analysis, the percentage of specific growth rates were arcsine converted. Differences were considered significant at $P < 0.05$. The differences among means were determined by Duncan's multiple range test (Duncan, 1955).

Results

1. Growth performance

The growth performance of common carp fries were performed in Table (2). Significant differences ($P < 0.05$) were observed among all dietary treatments. Fish fed M₁ diet (2.5 g/kg diet) gained the highest final weight (Fig. 1A), weight gain and weight gain % (Fig. 1B). Also, a decreasing trend was observed when the inclusion of marjoram leaves in the diets increased. In terms of specific growth rate (SGR %), fish fed M₃ gained the lowest value with significant differences among all treatments. Also, the lowest feed intake was found in fish fed M₃ diet with significant differences among all treatments ($P < 0.05$). Fish fed M₁ diet showed the best FCR and significantly differed ($P < 0.05$) among all treatments (Fig. 1C). Moreover, the protein efficiency ratio (PER) was higher in fish fed M₁ diet and significantly differed ($P < 0.05$) among all treatments. No significant differences were observed in the survival of fish fed the examined diets and fish fed M₃ diet gained the highest value (96.2%).

Table 2. The effect of marjoram leaves on the growth performance of common carp (*Cyprinus carpio*) fries. (Means \pm SD).

Parameters	Experimental diets*			
	CTRL	M ₁	M ₂	M ₃
Initial weight (IBW, g)	0.35 \pm 0.02	0.34 \pm 0.02	0.33 \pm 0.02	0.34 \pm 0.01
Final weight (FBW, g)	2.83 \pm 0.23 ^{bc}	4.48 \pm 0.48 ^a	3.46 \pm 0.35 ^b	2.53 \pm 0.46 ^c
Weight gain (WG, g)	2.48 \pm 0.22 ^{bc}	4.14 \pm 0.48 ^a	3.13 \pm 0.36 ^b	2.19 \pm 0.46 ^c
Weight gain percent (WG %) ¹	708.57 \pm 45.32 ^c	1217.65 \pm 159.23 ^a	948.48 \pm 120.32 ^b	644.12 \pm 111.72 ^c
Total feed consumed (g/fish)	7.00 \pm 0.37 ^{ab}	7.51 \pm 0.38 ^{ab}	7.83 \pm 0.24 ^a	6.51 \pm 0.89 ^b
Specific growth rate (SGR, %/d) ²	2.49 \pm 0.07 ^c	3.07 \pm 0.15 ^a	2.80 \pm 0.14 ^b	2.39 \pm 0.17 ^c
Feed conversion ratio (FCR) ³	2.83 \pm 0.15 ^a	1.82 \pm 0.13 ^b	2.50 \pm 0.20 ^a	2.97 \pm 0.45 ^a
Protein efficiency ratio (PER %) ⁴	1.18 \pm 0.06 ^b	1.83 \pm 0.13 ^a	1.33 \pm 0.11 ^b	1.12 \pm 0.16 ^b
Survival (%) ⁵	95.19 \pm 2.30	91.43 \pm 5.71	93.33 \pm 4.36	96.19 \pm 3.30

*CTRL= control; M₁, M₂ and M₃ diets with different levels of marjoram leaves 2.5, 5 and 10 (g/kg diet). Means in the same row with different superscript letters are significantly different (P < 0.05).

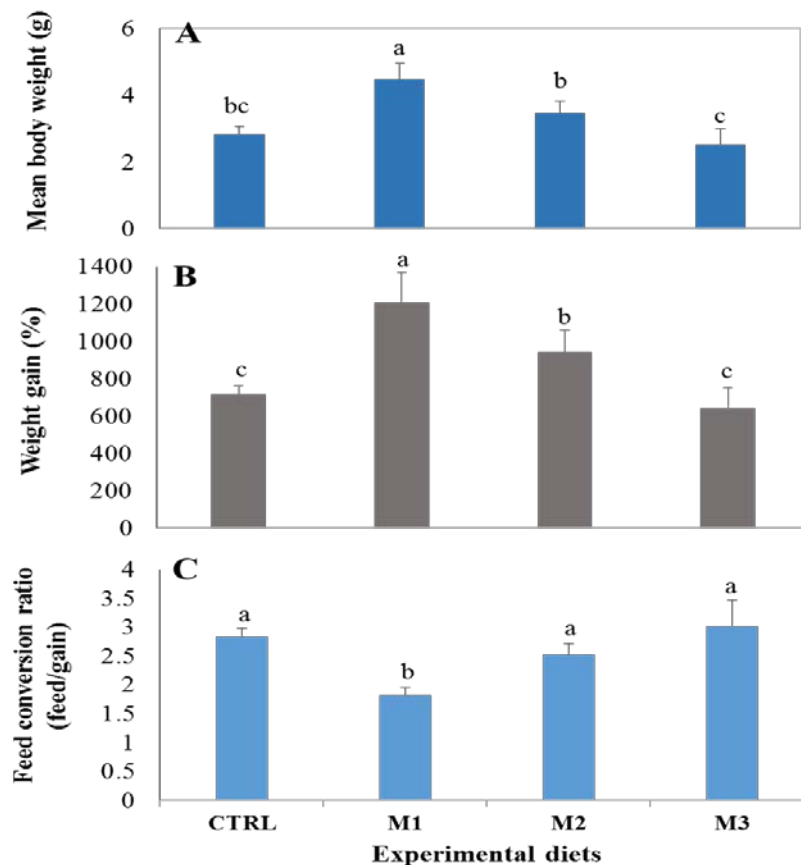


Figure (1). Mean body weight (A), weight gain % (B), and feed conversion ratio (C) of common carp fed experimental diets containing 4 different levels of marjoram leaves. Different superscripts among columns indicate significant differences at P < 0.05.

2. Body composition:

The whole fish body was analyzed and performed in Table (3). No significant differences were observed among all treatments in terms of dry matter. Moreover, significant differences ($P < 0.05$) were observed in the protein content of fish body and highest value was observed with fish fed M_3 diet. The increasing trend was observed by increasing the inclusion of marjoram leaves in the diets. The lipid content was similar among all treatments. Also, significant differences ($P < 0.05$) were observed in the ash content of the examined fish among all treatments and fish fed M_3 diet gained the highest value.

3. Biometric measurements:

The effects of marjoram leaves supplementation on the biological measurements of common carp, *Cyprinus carpio* fries fed the experimental diets are performed in Table 4. The inclusion of marjoram leaves in the experimental diets did not significantly ($P > 0.05$) affect the condition factor (K), gonadosomatic (GSI), and hepatosomatic (HSI). Furthermore, Fish fed M_1 diet gained the highest values and the lowest values were observed in fish fed M_3 diet. Significant differences ($P < 0.05$) were observed in viscerasomatic (VSI) indices values among all treatments. Fish fed M_1 diet exhibited the highest value, whereas, fish fed CTRL diet gained the

lowest value. A decreasing trend was observed in all biometric measurements among all treatments by increasing the inclusion level of marjoram leaves in the experimental diets compared to the control group.

Histological analysis:

Control common carp and groups fed diet supplemented with M_1 (2.5 g/kg) and M_2 (5 g/kg) of marjoram leaves showing normal histology of hepatic cells and pancreatic tissue with only congested hepatic sinusoids (Fig. 2 a, b and c); respectively. Fish fed diet supplemented with M_3 (10 g/kg) of marjoram leaves showing normal histology of hepatic cells and pancreatic tissue with normal hepatic sinusoids (Fig. 2 d). Moreover, the intestine of the examined fish were normal in the control group (Fig.3 a). Marjoram supplemented diets with different levels (2.5, 5 and 10 g/kg) had an increase in the goblet cells number as shown in (Fig. 3 b, c and d); respectively. The increasing of goblet cells was gradually observed with the increment of marjoram levels in the experimental diets. Furthermore, the examination of fish testis in all groups (control and marjoram supplemented diets) had normal seminiferous tubules with presence of spermatozoa in the lumen (Fig. 4 a, b, c and d). No diet-related histopathological changes were noted in all examined tissues of the fish among all treatments.

Table (3): Effect of marjoram leaves additive on the body composition (%) of common carp (*Cyprinus carpio*) fries reared in aquaria for 12 weeks. (Means \pm SD).

*Experimental diets	Dry matter	Crude protein	Lipid	Ash
CTRL	26.5 \pm 0.3	50.1 \pm 0.4 ^d	23.3 \pm 0.02	15.7 \pm 0.8 ^b
M_1	25.9 \pm 0.4	52.8 \pm 0.6 ^c	23.4 \pm 0.01	16.4 \pm 1.7 ^{ab}
M_2	26.3 \pm 0.6	56.3 \pm 0.2 ^b	23.5 \pm 0.02	16.1 \pm 1.0 ^{ab}
M_3	25.9 \pm 1.4	57.8 \pm 0.2 ^a	23.9 \pm 0.01	18.0 \pm 0.9 ^a

*CTRL= control; M_1 , M_2 and M_3 diets with different levels of marjoram leaves 2.5, 5 and 10 (g/kg diet). Means in the same column with different superscript letters are significantly different ($P < 0.05$).

Table (4): The effect of marjoram leaves supplementation on biometric measurements of common carp (*Cyprinus carpio*) fries. (Mean ± SD).

Parameters	Experimental diets			
	CTRL	M ₁	M ₂	M ₃
GSI	0.48±0.60	0.65±0.0.4	0.50±0.50	0.38±0.44
VSI	6.52±3.63 ^b	10.77±1.62 ^a	9.02±0.90 ^{ab}	8.65±0.89 ^{ab}
HSI	2.11±1.14	3.22±0.87	2.87±0.67	2.40±1.25
K	1.77±0.53	1.67±0.28	1.54±0.18	1.47±0.15

*CTRL= control; M₁, M₂ and M₃ diets with different levels of marjoram leaves 2.5, 5 and 10 (g/kg diet). Means in the same row with different superscript letters are significantly different ($P < 0.05$).

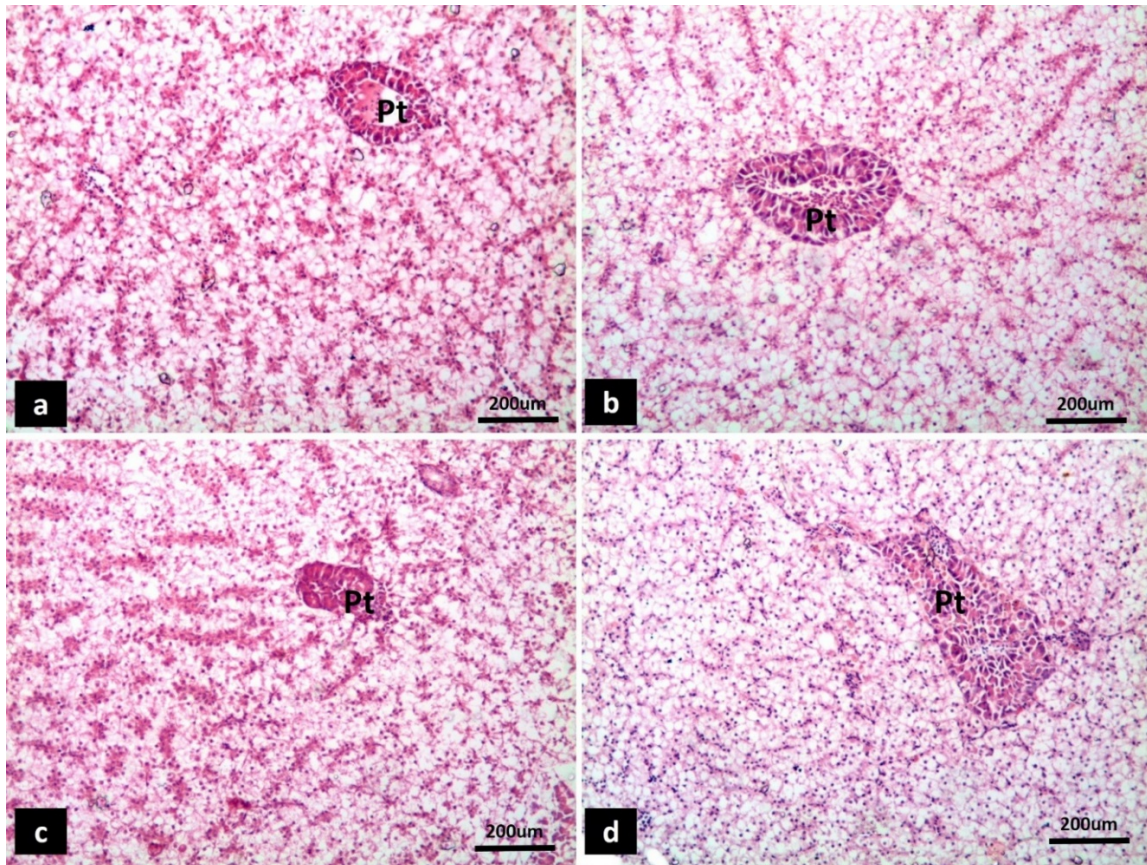


Figure (2). Liver of common carp fed diets supplemented with different levels of marjoram; (a) control group and (b and c) fish groups fed basal diet supplemented with 2.5 and 5 g/kg of marjoram; respectively, showing normal hepatocytes, congested sinusoids and normal pancreatic tissue (Pt). (d) fish group fed basal diet supplemented with 10 g/kg of marjoram showing normal hepatocytes, sinusoids and pancreatic tissue. H&E (X10).

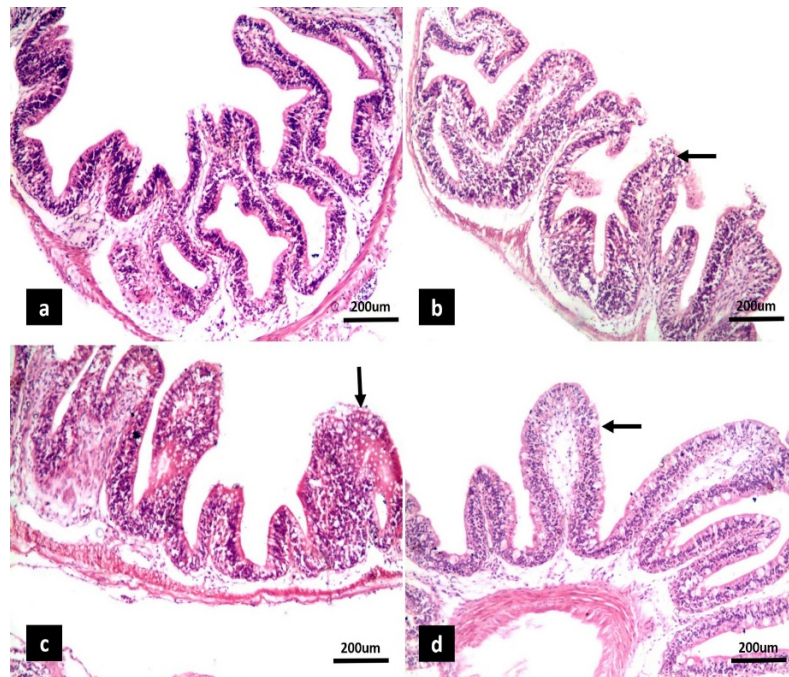


Figure (3). Intestine of common carp fed diets supplemented with different levels of marjoram; (a) control group showing normal appearance of intestine (b, c and d) fish groups fed basal diet supplemented with 2.5, 5 and 10 g/kg of marjoram; respectively, had an increase in goblet cells number (arrow). H&E (X10).

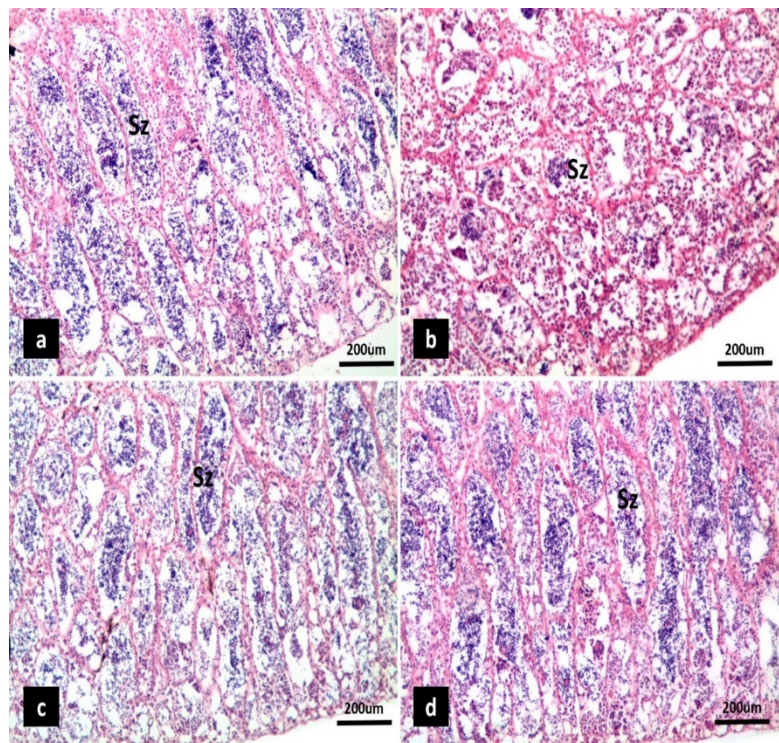


Figure (4). Testis of common carp fed diets supplemented with different levels of marjoram; (a) control group and (b, c and d) fish groups fed basal diet supplemented with 2.5, 5 and 10 g/kg of marjoram; respectively, showing normal seminiferous tubules with the presence of spermatozoa in the lumen (Sz). H&E (X10).

Discussion

The experiment was conducted to evaluate the influence of marjoram leaves inclusion in the diets for common carp (*Cyprinus carpio*) fries on the performance, body composition, organs indices and tissues histology after 12 weeks feeding trial. Previous studies were investigated the using of herbal plants in the diets and its influences on fish and shrimp performance (El-Kholy 2012; Yin *et al.*, 2006; Jian and Wu *et al.*, 2004). Significant differences were observed in growth performance among all treatments (Table 2). Fish fed diet supplemented with 2.5g marjoram leaves/kg diet (M₁) gained the highest values of final weight (Fig. 1A), weight gain, weight gain % (Fig. 1B) and specific growth rate. Abd El- Maksoud (1999) found the highest value of weight gain of Nile tilapia fingerlings when fed 3 % of dietary marjoram.

These results are disagree with Abd El-Maksoud *et al.*, (2002) who indicated lower performance when fed Nile tilapia fingerlings diets contained 0.5 - 1% of chamomile flowers, Nigella seed or marjoram leaves alone than control. This may be attributed to the fish species, life stage, the level and kind of herbal plants. In our research, fish fed M₃ diet (10g/kg) consumed less amount of the diet reflected on the worst FCR compared to other groups (Fig. 1 C). The feed consumed decreased by increasing the inclusion level of marjoram. It can be explained that marjoram contained tonic and astringent bitter principles which rouse the appetite thus, it is beneficial for invalids (Mabey, 1988). No significant differences were found in survival rate among all treatments (Table 2), and fish fed M₃ diet gained the highest value.

These reveal the safety of marjoram leaves as feed additive in the diets. The same results were reported by Abd El-Maksoud *et al.*, (1999) when fed diets supplemented with marjoram leaves at 0, 0.5, 1, 2, and 3 % to Nile tilapia fingerlings. The results of whole-body composition (Table 3) indicated that the inclusion of marjoram leaves has a positive effect on crude protein and ash content of fish body. These results are disagree with those found by El-Kholy (2012) when fed

hybrid tilapia (*Oreochromis niloticus* × *O. aureus*) fingerlings different levels (150, 300 and 600 mg/kg) of supplemented herbal plants (Sage and/or marjoram) and reported negative effect on ash and protein contents. The same author reported significant increase in lipid and gross energy content by adding herbal plants. In our research, the lipid content were similar among all treatments. Previously, (Jeong *et al.*, 2007) suggested that no differences of whole-body composition of the examined fish were found when herbal plants were added as growth promoter in the diets. The effect of marjoram leaves on biometric measurements of common carp (*Cyprinus carpio*) are presented in Table 4. No significant differences were found among all treatments in terms of GSI, HSI and K. The differences of VSI were observed among all treatments and the highest value was found in fish fed M₁ diet. The histological examination of liver, intestine and testis of the tested fish indicated that the supplementation of marjoram leaves in the diets for common carp (*Cyprinus carpio*) is safe and did not have adverse effects on the health status.

Conclusion

From the obtained results, marjoram leaves can be added to the diets for common carp fries at 2.5 g/kg to improve the performance and feed utilization without any adverse effects. The normality of all examined fish tissues indicated that marjoram leaves are safe to use in fish diets. More studies are needed to examine the effects of marjoram leaves on the hematology, immune parameters of fish and the microbial community in fish gut to improve the quality of fish health and increase the use of herbs in fish nutrition as natural growth promoter to improve the fish diets which reflected on increasing the fish production.

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تأثير إضافة مسحوق أوراق البردقوش علي أداء النمو وتركيب الجسم لزريعة أسماك المبروك العادي.

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الملخص العربي

أجريت هذه الدراسة لتقييم تأثير إضافة مسحوق أوراق البردقوش بمستويات مختلفة (صفر, ٢,٥, ٥ و ١٠ جم لكل كجم عليقة) في علائق زريعة أسماك المبروك العادي. ٤٢٠ زريعة تم توزيعها عشوائياً في أربعة معاملات بثلاث مكررات في ١٢ حوض زجاجي وتم تغذيتها علي العلائق التجريبية ٤ مرات في اليوم. أوضحت النتائج أن إضافة مسحوق أوراق البردقوش في علائق زريعة أسماك المبروك العادي أظهرت تأثير معنوي علي النمو والأداء بين كل المعاملات وتم ملاحظة الاتجاه التنازلي بزيادة معدل الإضافة. الأسماك المغذاة علي عليقة مضاف لها ٢,٥ جم من مسحوق أوراق البردقوش كانت الأفضل في معدل التحول الغذائي واختلفت معنوياً عن المعاملات الأخرى. لم تظهر أي اختلافات معنوية في معدل الحيوية بين كل المعاملات و الأسماك المغذاة علي عليقة مضاف لها ١٠ جم من مسحوق أوراق البردقوش كانت الأعلى قيمة. لم تظهر أي اختلافات معنوية بين كل المعاملات في محتوى الجسم من المادة الجافة. و تم ملاحظة فروق معنوية في محتوى الجسم من البروتين وكانت أعلى قيمة في الأسماك المغذاة علي عليقة مضاف لها ١٠ جم من مسحوق أوراق البردقوش- وكان محتوى الجسم من الدهن متشابه بين كل المعاملات. لم تظهر أي اختلافات معنوية بين كل المعاملات في معامل المناسل، معامل الحالة ومعامل الكبد- وظهرت فقط اختلافات معنوية في معامل الأحشاء. لم تظهر أي تغييرات هستولوجية في أنسجة الكبد و الأمعاء و المناسل المختبرة نتيجة التغذية علي العلائق التجريبية بين كل المعاملات.

وأوضحت الحالة الطبيعية لأنسجة الجسم المختبرة هستولوجياً بعد فترة التغذية أمان استخدام مسحوق أوراق البردقوش في علائق الأسماك وأنه يمكن إضافته بمعدل ٢,٥ جم لكل كجم عليقة لتحسين الأداء والاستفادة الغذائية في علائق زريعة أسماك المبروك العادي بدون أي تأثيرات سلبية.