The Effects of Partial Replacement of Fish-Meal with Mesquite Pods on Growth Parameters of Tilapia Fry, Oreochromis mossambicus

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Abstract

This study was carried out to determine the effect of partial replacement of fish-meal with 15%, 30% and 45% of Mesquite pods (MP) in testing diets on growth parameters of Tilapia fries, *Oreochromis mossambicus* which reared in glass aquarium for 12 weeks. Twenty *O. mossambicus* fries (Mean initial weight 3.33 g) were randomly distributed into each 12 glass aquariums (measuring 50 x 50 x 50 cm) filled with tap water to 40 cm depth. Four treatments were formulated in this experiment. The first treatment was controlled and three testing diets contain 15%, 30% and 45% of MP. The results showed that the replacement of fish meal with Mesquite pods significantly reduced all growth parameters such as final weight, weight gain, food conversion ratio, specific growth rate, relative growth rate and protein efficiency ratio and survival of Tilapia fries *Oreochromis mossambicus* compared with control (without Mesquite pods) . The highest final performance weight of 67.33g was obtained in fish fed on control diet and the lowest weight was 44.53g with fish fed on 45% MP in testing diet. Also when using Mesquite pods as partial replacement of fish meal observed significantly elevated in all proximate composition of fish such as lipid, fiber and ash, except protein. From these results, it can be concluded that fish fed on testing diets had the acceptable growth performance when fish-meal was replaced with 15%, 30% and 45% of MP in testing diets.

Keyword: growth parameters, *Oreochromis mossambicus,* proximate composition, mesquite pods

Introduction:

It is known that Tilapia fish has high economic value due to its high productivity, fast growth and having adaptive aspects for any environmental cultured condition; so they are considered the best option for the development of aquaculture in the world because of its ability of natural reproduction easily [10].

Fish-meal using in fish diets due to its good composition of: protein, vitamins, minerals, essential fatty acids and low in fiber and carbohydrate [14]; it has contained high quality of protein, balanced with necessary amino acid, highly digestible and palatable to fish[8]. Consequently, the global requirements of fish-meal have been increasing in order to use it in fish diets [8]. Using fish-meal in diets for aquaculture has been gradual reduced due to decreasing the natural fish-meal stocks [8]. Therefore, the price of fish-meal is expensive; then aqua farming going to look for different sources which are suitable in cost and protein such as plant sources that are possible alternative fish-meal in the fish diets [3,8].

It is known that mesquite tree**,** *Prosopis Julifora* is very cheaper and covered about 24,000 – 30,000 hectares in Yemen; it is increasing year after year [1]. The protein in mesquite flour is 11 – 17 % which is important in the human and animal nutrition [1]. So far, the price of fish-meal is expensive due to reducing its production globally; therefore, aqua farming going to looking for different sources that are suitable in cost and protein such as plant-derived ingredients that are possible alternative fish-meal in the fish diets. Concequently, the present study was conducted to determine the effect of partial replacement of fish-meal with pods of mesquite on growth parameters of Tilapia *O. mossambicu*, as well as to determine the suitable amount of Mesquite pods in Tilapia diets.

Materials and Methods:

Experimental Fish:

About 1,000 Tilapia *O. mossambicus* fries were caught from Wadi Hajr stream in February 2015 and used in this study. They were adapted to laboratory conditions for two weeks before starting the experiment in laboratory of Marine Biology at Faculty of Environmental Science and Marine Biology, Hadhramout University.

Twenty Tilapia *O. mossambicus* fries (Mean initial weight 3.33 g) were randomly distributed into each 12 glass aquariums (measuring 50 x 50 x 50 cm) filled with tap water to 40 cm depth (Figure1). Fish groups were maintained in triplicates for each treatment under natural photoperiod of approximately 12/12 hours

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light/dark cycle. Four treatments were conducted in this experiment. The first treatment was control, the second treatment was testing diet with 15% of Mesquite pods (MP), the third treatment was testing diet with 30% of MP and the fourth treatment was testing diet with 45% of MP as shown in Table 1.

The water of glass aquariums was refilled every two days when it appeared dirty until the end of the experiment. The experiment continued for 12 weeks. The fish in each glass aquariums were sampled biweekly and weighed in bulk, except at the start and end of the experiment where the fish were weighed individually.

Figure 1: Tilapia *O. mossambicus* fries rearing in glass aquarium

Diets Preparation:

Four experimental diets were formulated containing about 32.93% crude protein, using fish-meal and Mesquite pods as the protein source. Lipid levels in the four diets were retained about 9.92 %, of corn oil. The ingredients and proximate composition of the experimental diets are shown in Table 1.

Each diet was prepared by mixing well the dry ingredients manually followed by the addition of corn oil. Then, water was added to the mixed ingredients which were kneaded into dough. The dough was pelleted with a pellet machine into small pellets. The resulting pellets were dried in an oven at about 60ºC for 24 hours.

Table 1: The ingredients and proximate composition of four experimental diets

Ingredients	Control	15%MP[6]	30% MP	45% MP
[1]Fish-meal	55.63	48.98	42.15	35.50
Mesquite pods (MP)	00.00	15.00	30.00	45.00
Starch	36.37	27.72	19.15	10.50
Corn oil	4.0	4.3	4.7	5.0
[2]Vitamin mix	2	2	2	2
[3]Mineral mix	2	2	2	2
Proximate analysis (% dry weight)				
Protein	33.00	32.97	32.89	32.89
Lipid	9.88	9.84	9.96	9.95
Fiber	0.00	4.10	8.19	12.29
Ash	11.58	11.56	11.78	12.11
[4]NFE	45.54	41.53	37.18	32.76
[5]Gross energy(Cal /100g)	464	447	431	413

[1]Local fish-meal

[2]Vitamin mix kg^{-1}(ROVIMIX 6288, Roche Vitamins Ltd., Switzerland): Vit.A 50 million i.u., Vit.D_3 10 million i.u., Vit.E 130g; Vit.B_1 10g; Vit.B_2 25g; Vit.B_6 16g; Vit.B_{12} 100 mg; Biotin 500 mg; Pantothenic acid 56g; Folic acid 8g; Niacin 200g, Anticake 20g; Antioxidant 200mg, Vit.K_3 10 g and Vit.C 35g

[3]Mineral mix kg^{-1}: Calcium phosphate(monobasic) 397.65g; Calcium lactate 327g; Ferrous sulphate 25g; Magnessium sulfate 137g; Potassium chloride 50g; Sodium chloride 60g; Potassium iodide150mg; Copper sulphate 780mg; Manganese oxide 800mg; Cobalt carbonate 100mZinc oxide 1.5g and Sodium selenite 20mg

[4] NFE = Nitrogen free extract [100 – (protein + lipid +ash + fiber)]

[5]GE = Gross energy (calculated based on 5.7 Cal/g protein; 9.5 Cal/g lipid; 4.0 Cal/ g carbohydrate

[6]MP=Mesquite pods in the testing diet

Feeding Trial:
The feeding trial of experiment was conducted in four treatments whose design is completely random. Tilapia *O. mossambicus* fries were fed twice daily with hand until satiety at 08:00 and 18:00 hours. Feeding was stopped during sampling for 24 hours biweekly when fish were weighed to observe growth parameters and to clean glass aquariums.

Calculations:
The following formulae were applied where necessary to calculate different parameters:
Specific growth rate (SGR%) = [(ln W_f - ln W_i) / T] x 100
Relative growth rate (RGR%) = [(Wf - Wi) / Wi] x 100
Feed conversion ratio (FCR) = [total feed intake (g)] / [total wet weight gain(g)]
Protein efficiency ratio (PER) = [Wet weight gain (g)] / [Total protein intake]
Survival rate (%) = [Number of fish which survived] / [initial number of fish] x 100
Where W_f refers to the mean final weight, W_i is the mean initial weight of fish and T is the feeding trial period in days.

Proximate Composition:
The proximate composition of fish and diets: moisture, protein, fat and ash were analyzed using association of official analytic chemist's methods [2]. Moisture content was determined using an AND-4712 Infrared Moisture Determination Balance; 4 g of feeds and fish carcasses were respectively spread on the plate of balance in triplicate. Crude protein was measured using the Kjeldahl method. One gram of samples was accurately weighed and placed into a Kjeldahl flask, and then 10 g of catalyst and 25 ml of concentrate sulphuric acid was added into the flask. The samples were heated at 250 ^oC for 2 hours. After that, the samples were cooled for 10 minutes, 300 ml distilled water and 100 ml of 40 % NaOH were added into the flask. Diluted samples were distilled and this was followed by titration using 0.1 N HCl. Further, crude lipid was measured after chloroform-methanol extraction was performed. Samples were homogenized with a high speed homogeniser for 5 minutes and lipid was determined gravitirially after solvent separation and vacuum drying while ash and fibre were calculated from the weight loss after incineration of the sample for 24 hours at 550 ^oC in a muffle furnace.

Statistical Analysis:
The difference in each growth parameters such as final fish weight, weight gain, food conversion ratio, specific growth rate, relative growth rate and protein efficiency ratio and survival % and proximate composition of fish four experimental diets using one way ANOVA (Analysis of Variance) followed by Tukey test using SPSS software packages, version 18 and to determine the effect of Covariance (difference in initial weight) using ANCOVA test (Analysis of covariance). For all statistical test, ($P<0.05$ was considered as significant).

Results:
Growth Parameters:
Data for growth parameters of Tilapia *O. mossambicus* fries fed different diets over 12 weeks. Culture period is summarized in Table 2. The results of the present study showed that there were significant differences (*P<0.05*), using one way ANOVA, regarding the growth parameters: final weight, weight gain, food conversion ratio (FCR), specific growth rate (SGR), relative growth rate (RGR) and protein efficiency ratio (PER), except survival. The best growth parameters: final weight, weight gain, FCR, SGR, RGR and PER were achieved in fish fed control diet compared to testing diets. However, fish fed on 15% MP testing diet was superior and has best growth parameters compared to 30%, and 45% MP testing diets.

Table 2: Mean ± SD of growth parameters of Tilapia *O. mossambicus* fries fed different diets over the 12 weeks culture period in glass aquariums.

Parameter	Treatments			
	Control	15%MP[1]	30%MP	45%MP
Final weight	67.33±3.21^b	46.10±0.17^a	45.10±1.14^a	44.53±2.16^a
WG	63.54±3.13^b	42.93±0.30^a	41.31±1.40^a	41.23±2.26^a
FCR	1.28±0.05^a	1.91±0.02^b	2.06±0.08^b	2.04±0.11^b
SGR	3.28±0.16^b	3.19±0.12^b	2.96±0.22^{ab}	3.10±0.10^b
RGR	1486±214^c	1363±156^{bc}	1118±223^{ab}	1252±116^{abc}
PER	2.45±0.16^b	1.59±0.01^a	1.47±0.06^a	1.49±0.08^a
Survival	100±0.00^a	98.33±2.88^a	100±0.00^a	100±0.00^a

Mean values in the same row with different superscripts show significant difference ($P<0.05$)
[1]MP = Mesquite pods in the testing diet

Proximate Composition:

The results of the present study showed that there were significant differences (*P<0.05*), using one way ANOVA, regarding the proximate composition of fish: lipid, fiber and ash, except protein as summarized in Table 3.

The highest protein value was achieved in fish which fed on 15% MP testing diet followed by fish fed on 30% MP, control and 45%MP diets, respectively. The highest lipid value was obtained in fish which fed on control diet and the lowest lipid rate was found in fish that fed on 45% MP testing diet. Besides, the highest fiber and ash were obtained in 45% and 15% MP testing diet, respectively and the lowest fiber and ash were attained in fish fed on control diet.

Table 3: Mean ± SD of dry proximate composition of Tilapia O. mossambicus fries fed different diets over the 12 weeks culture period in glass aquariums.

			Treatments	
Parameter	Control	15%MP[1]	30% MP	45% MP
Protein	53.33±0.01^{a}	54.68±1.51^{a}	54.24±0.04^{a}	53.17±0.86^{a}
Lipid	12.57±1.00^{c}	11.78±0.90^{bc}	11.27±0.99^{abc}	10.35±0.98^{ab}
Fiber	13.92±1.00^{a}	15.55±0.98^{ab}	15.05±0.99^{ab}	15.90±0.970^{b}
Ash	15.43±1.00^{a}	17.55±0.20^{b}	17.04±1.00^{b}	16.10±0.72^{ab}

Mean values in the same row with different superscripts show significant difference (*P*<0.05)

[1]MP = Mesquite pods in the testing diet

Discussion:

The results of the present study showed that there were significant differences (*P<0.05*), regarding the growth parameters of Tilapia *O. mossambicus* fries: final weight (FW), weight gain (WG), food conversion ratio (FCR), specific growth rate (SGR), relative growth rate (RGR) and protein efficiency ratio (PER) (Table 2). The best growth parameters: FW, WG, FCR, SGR, RGR and PER were achieved in fish fed on control diet compared to fish fed on testing diets. However, fish fed on 15% MP testing diet was superior and had the best growth parameters compared to 30%, and 45% MP testing diets. These observations probably indicate that the growth performance of fish is decreasing with the increasing replacement of fish-meal with the percentage of protein coming from plant source in MP testing diets; this agrees with authors [12,15,13,11,5,16,6,9] who reported that the growth parameters: WG, FCR, SGR and PER of Tilapia *Oreochromis niloticus* were affected negatively when it was fed on diets contain protein coming from plants sources ; for example, percentages of fish-meal were replaced with the plant-derived ingredients in fish diets. Also, [8] pointed out those growth parameters: WG, FCR and SGR of Atlantic Salmon were affected negatively when ratios of fish-meal were replaced with the extracted sunflower meal, soy protein concentrate and feather meal in diets of this species. Besides, the negative effects of growth parameters of fishes could appeared due to the occurrence of a wide-ranging of antinutritional substances in plant-derived ingredients, which include: protease inhibitors, phytates, glucosinolates, saponins tannins, lectins, oligosaccharides and non-starch polysaccharides, phytoestrogens, alkaloids, antigenic compounds, gossypols, cyanogens, mimosine, cyclopropenoid fatty acids, canavanine, antivitamins, and phorbol esters [7].

In the present study, there were significant differences (*P<0.05*) regarding the proximate composition of fish: lipid, fiber and ash, except protein (Table 3). All in all, the amount of protein in fish tissues was mostly equal in all treatments. This observation explained that it is not important if the source of protein, which used in fish diets, is fish-meal or plant-derived ingredients. These results agree with author [4] who mentioned that there were no significant differences between protein contents of tin foil barb, *Barbodes altus* when fish-meal was replaced up to 50 % with soybean meal in the fish diets. However, [9] reported that there were significant differences between protein contents of Tilapia, *Oreochromis niloticus* fingerlings when Jojoba meal ratios increased in the diets instead of fishmeal up to 100 %; this finding may be related with the type of plant, Jojoba meal.

In addition to, the highest fiber and ash were obtained in 45% and 15% MP testing diet, respectively and the lowest fiber and ash were attained in fish fed on control diet. These observations indicated that the amount of fiber and ash are better in fish tissues when the MP were used in fish testing diets. This result is in

agreement with author [9] who reported that ash contents in Tilapia had increased when Jojoba meal ratios increased in the fish diets instead of fish-meal.

From the results of present study, it can be concluded that in general the growth performance of fish is affected negatively when fish-meal was replaced with plant-derived ingredients in MP testing diets of fish; however, the growth performance of fish is acceptable when fish-meal was replaced with Mesquite pods in fish testing diets from 15% until 45%.

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تأثيرات الاستبدال الجزئي لمسحوق السمك بقرون السيسبان في نمو يرقات أسماك البلطي
(Tilapia, Oreochromis mossambicus)

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الملخص

أجريت هذه الدراسة لتحديد تأثير الاستبدال الجزئي لمسحوق السمك بنسبة 15٪ ، 30٪ و 45٪ من مسحوق قرون السيسبان (mesquite pods) في مؤشرات النمو ليرقات البلطي التي تم تربيتها في اثني عشر حوضًا زجاجيًا لمدة اثني عشر أسبوعاً. تم توزيع عشرين يرقة بلطي (متوسط الوزن الأولي 3.33 جم) بشكل عشوائي في كل حوض زجاجي (قياس 50 × 50 × 50 سم) مملوءة بماء الحنفية إلى عمق 40 سم. صممت أربع معاملات في هذه التجربة، كانت المعاملة الأولى هي الشاهد، المعاملة الثانية تحتوي على 15 ٪ من مسحوق قرون السيسبان، المعاملة الثالثة تحتوي على 30 ٪ من مسحوق قرون السيسبان و المعاملة الرابعة تحتوي على 45 ٪ من مسحوق قرون السيسبان. أظهرت النتائج وجود فروق ذات دلالة إحصائية ($P < 0.05$) فيما يتعلق بمؤشرات النمو: الوزن النهائي ، زيادة الوزن، نسبة تحويل الغذاء، معدل النمو المحدد ومعدل النمو النسبي ونسبة كفاية البروتين. تم الحصول على أعلى وزن نهائي قدره 67.33 جم في الأسماك التي تغذت على معاملة الشاهد ، بينما كان الوزن الأدنى 44.53 جم للأسماك التي تغذت على المعاملة الرابعة التي تحتوي على 45 ٪ من مسحوق قرون السيسبان. أيضا، أظهرت النتائج أن هناك فروقاً ذات دلالة إحصائية ($P < 0.05$) فيما يتعلق بتركيب الجسم التقريبي للأسماك: الدهون والالياف والرماد، باستثناء البروتين. من هذه النتائج، يمكن أن نستنتج أن الأسماك التي تغذت على المعاملات التجريبية كان نمو اليرقات فيها مقبولاً عندما تم استبدال مسحوق السمك بنسبة 15 ٪ و 30 ٪ و 45 ٪ من مسحوق قرون السيسبان.

الكلمات ذات الدلالة: مؤشرات نمو الأسماك، يرقات البلطي، قرون السيسبان، تركيب الجسم التقريبي.