Use of moringa, *Moringa oleifera* leaf meal as partial replacement of soybean meal in common carp feed

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Abstract

A laboratory experiment was conducted to investigate the replacement of soybean meal with moringa, *Moringa oleifera* (Author's name and year) leaf meal (MLM) in the formulated diet of common carp, *Cyprinus carpio*. Eight aquaria, two for each treatment, were used for the current experiment conducted at the Laboratory of Live Food- Aquaculture Unit-Agriculture College. Four treatments which were control (C) (0% MLM), T1 (5% MLM), T2 (10% MLM) and T3 (15% MLM) were used in feeding common carp. This experiment lasted 56 days and fishes were fed six days a week using 5% of fish weights as feeding ratio. Statistical analysis of weight increments and daily growth rate proved that there were significant differences ($P \leq 0.05$) between T3 and other treatments, while there were no significant differences ($P > 0.05$) between C and both T1 & T2. Best feed conversion rate (3.13) achieved by fishes fed on feed with 5% moringa leaf meal (T1), while the worst feed conversion rate (7.50) was achieved by fishes fed on feed with 15% moringa leaf meal (T3). In conclusion that better growth and feed conversion rate achieved by fishes fed on feed with 5% moringa leaf meal and increasing the ratio in the feed will affect adversely the results.

Keywords: Aquaria, Weight increment, Daily growth rate, Feed conversion rate

Introduction

Mehta *et al.* (2011) stated that moringa, *Moringa oleifera* is a highly valued plant, distributed in many tropical and subtropical countries and has an impressive range of medicinal uses with high nutritional value, and different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics. The humble plant moringa is the most nutrient-rich plant yet discovered and it has been making strides in less-developed societies for thousands of years, so significant nutritional researches conducted since the 1970s (Mahmood *et al.* 2010). Capsules of dried moringa leaf powder have become a popular feed supplement for many people in Thailand (Wangcharoen and Gomolmanee, 2011). Moringa tree one of the world's most useful trees, that every part of it can be used ~~for~~ feed or for other beneficial purposes (Fahey, 2005; Zaku *et al.*, 2015).

Moringa leaves are highly nutritious and small leaves are edible and commonly cooked and eaten like spinach (Zaku *et al.*, 2015). The leaves can be ground into a fine powder that can be added to almost any food as a nutrient supplement (Makkar and Becker, 1997). Gardener and Ellen (2002) stated that the protein quality of moringa leaves compares very well with that of milk and eggs. Moringa leaves contain seven times the vitamin C of oranges, four times the vitamin A of carrots, four times the calcium of milk, three times the potassium of bananas and two times the protein in yoghurt (Gopalan *et al.*, 1989). Johnson (2005) observed that the leaf, seed and fruits of moringa are naturally rich sources of vitamins and minerals, where analysis of 100 g of the edible portion of fresh moringa leaves parts have shown to contain much of the following water soluble vitamins: 2.6 mg of vitamin B1, 20.5 mg of vitamin B2, 8.2 mg of vitamin B3 and 220 mg of vitamin C. Johnson (2005) also mentioned that 100 g of the edible portion of fresh moringa leave contains 2003 mg of calcium, 368 mg of

magnesium, 204 mg phosphorus, 1324 mg of potassium, 3.1 mg of copper, 28.2 mg of iron and 870 mg of selenium.

Ozovehe and Nzeh (2013) stated that high cost and fluctuating quality as well as the uncertain availability of fish meal have led to the need to identify alternative protein sources for fish feed formulation, therefore, ~~in order~~ to attain more economically sustainable materials, researches should be directed towards the evaluation and use of nonconventional sources of plant protein. The most important characteristics of moringa are the high biological and nutritional values that can be used as animal feed, green fertilizer, medicine and biopesticide (Abd El-Hack *et al.*, 2018). Chuks *et al.* (2013) stated that there is an urgent need to examine other products such as moringa as an alternative source of protein in aquaculture feeds, because most of the conventional plant/animal feed sources are equally in great demand for human consumption, and they emphasize that there is a little information on the use of moringa leaf or seed meals as fish feed ingredients.

Some researcher studied the effects of replacement moringa leaf with other fish feed ingredient on different growth criteria (Afung *et al.*, 2003; Richter *et al.*, 2003; Yuangsoi and Masumoto, 2012; Ozovehe and Nzeh, 2013; Hlophe and Moyo, 2014; Karina *et al.* 2015; Puycha *et al.* 2017). The aim of the current experiment is to investigate the ability to use moringa leaves as partial replacement of soybean meal in the formulated feed of common carp (*Cyprinus carpio*), since soybean prices in Iraq comparable to the prices of fish meal which considered high in respect to other ingredients.

materials and methods

A laboratory experiment was conducted to investigate the replacement of soybean meal with moringa leaf meal (MLM) in the formulated diet of common carp. Pelleted feed

manufactured in the laboratory using raw materials with changing the ratio of soybean and MLM (Table, 1). Common carp (Average weight 8.55 g) brought from earthen ponds of Aquaculture Unit located in Hartha Station for Agricultural Researches, North Basrah. Eight aquaria, two for each treatment, of dimensions (60×40×30) cm provided with pumping aeration, were used for the current experiment ~~which~~ conducted at the Laboratory of Live Food- Aquaculture Unit-Agriculture College. Four treatments which were, control (0% MLM), T1 (5% MLM), T2 (10% MLM) and T3 (15% MLM) were used in feeding common carp of current experiment. This experiment lasted 56 days and fishes were fed six days a week using 5% of fish weight as feeding ratio. Fishes were weighed periodically to alter daily feed.

Growth parameters such as specific growth rate (SGR), daily growth rate (DGR) and weight increment (WI), in addition to feed conversion rate (FCR) were calculated according to the following equations:

$SGR = \{(\ln w_2 - \ln w_1)/t\} \times 100$

$DGR = (w_2 - w_1)/(t_2 - t_1)$

$WI = w_2 - w_1$

FCR = Feed consumed/weight increased

Where w_1 is initial weight, w_2 is final weight, t_1 is the time at w_1 and t_2 time at w_2.

Table (1) Percent of feed ingredients in the formulated feeds.

Feed Ingredients (%)	Treatment (Diets)			
	Control	T1	T2	T3
Wheat flour	30	30	30	30
Wheat bran	26	26	26	26
Fishmeal	20	20	20	20
Soybean meal	20	15	10	5
Moringa Leaf Meal	0	5	10	15
Vitamins and minerals premix	2	2	2	2
Vegetable oil	2	2	2	2

By application of SPSS (version 22), the data were subjected to one-way analysis of variance (ANOVA) to determine the difference between the means and the significant differences were tested by LSD Test.

Results

Table (2) shows the measurements of fish weight with standard deviation during the experiment. Highest final weight (16.59 g) reached by fish of T1 in aquarium 4, while lowest final weight (11.07 g) reached by fish of T3 in aquarium 8. Table (3) show the growth criteria of different treatments in the experiment. Weight increments were (5.65, 7.03, 5.15 and 2.97) g for C, T1, T2 and T3 respectively.

Table (2) Measurements of average fish weight during the experiment.

Date	Average Fish Weight (g) ±SD							
	CP1	CP2	T1P3	T1P4	T2P5	T2P6	T3P7	T3P8
5-5-2019	8.79 ±2.70	8.46 ±2.94	8.42 ±1.20	9.61 ±3.20	8.67 ±1.62	8.61 ±2.67	7.43 ±2.21	8.41 ±1.33
19-5	9.34 ±3.01	9.04 ±3.26	8.89 ±1.78	9.99 ±3.89	9.67 ±1.99	8.72 ±2.75	8.20 ±2.51	8.04 ±1.51
2-6	10.52 ±3.31	10.34 ±3.51	10.17 ±2.51	12.77 ±3.54	10.31 ±2.54	9.72 ±2.61	9.06 ±2.51	8.66 ±1.80
16-6	12.52± 3.51	12.00 ±3.71	11.66 ±3.11	14.66 ±3.92	12.29 ±2.92	10.91 ±2.60	9.83 ±2.80	9.91 ±2.03
30-6	14.11± 3.93	14.44 ±3.84	15.50 ±3.32	16.59 ±4.13	14.61 ±3.14	12.98 ±2.98	11.62 ±2.62	11.07 ±2.34

Statistical analysis of weight increments proved that there were significant differences ($P \leq 0.05$) between T3 and other treatments and also significant differences ($P \leq 0.05$) between T1 & T2 while there were no significant differences ($P > 0.05$) between C and both T1 & T2.

Results appeared that average values of daily growth rate were (0.101, 0.125, 0.092 and 0.052) g/day for C, T1, T2 and T3 respectively Statistical analysis of daily growth rate appeared that there were significant differences (P≤0.05) between T3 and other treatments, while there were no significant differences (P>0.05) between C and both T1 & T2. Also, there were significant differences (P<0.05) between T1 and T2 in the daily growth rate.

Table (3) Growth criteria of different treatments in the experiment.

Growth Criteria	Treatments							
	C		T1		T2		T3	
	P1	P2	P3	P4	P5	P6	P7	P8
WI (g)	5.32	5.98	7.08	6.98	5.94	4.37	3.28	2.66
Average	5.65 ab		7.03 a		5.15 b		2.97 c	
DGR (g/day)	0.095	0.107	0.126	0.125	0.106	0.078	0.058	0.047
Average	0.101 ab		0.125 a		0.092 b		0.052 c	
SGR (%/day)	0.84	0.95	1.09	0.97	0.93	0.73	0.59	0.49
Average	0.89 a		1.03 a		0.83 a		0.54 b	
FCR	4.01	3.93	3.04	3.23	3.99	4.67	6.76	8.24
Average	3.97 a		3.13 a		4.33 a		7.50 b	

Different letters in one row are significantly different (P≤0.05).

Average values of specific growth rate were (0.89, 1.03, 0.83 and 0.54) %/day for C, T1, T2 and T3 respectively. Statistical analysis of specific growth rate appeared that there were significant differences (P≤0.05) between T3 and other treatments, while there were no significant differences (P>0.05) among C, T1 and T2. Best feed conversion rate (3.13) achieved by fishes fed on feed with 5% moringa leaf meal (T1), while the worst feed conversion rate (7.50) was achieved by

fishes fed on feed with 15% moringa leaf meal (T3). Statistical analysis of feed conversion rate showed that there were

significant differences ($P \leq 0.05$) between T3 and other treatments, while there were no significant differences ($P > 0.05$) among C, T1 and T2. The final conclusion of the results depending on growth criteria was that better growth and feed conversion rate achieved by fishes fed on the feed with 5% moringa leaf meal (T1) and increasing the ratio in feed will affect adversely the results.

Discussion

There are many factors related with the growth of cultivated fish such as the culture design, kind of fish feed, feeding regime, feeding administration and environmental factors. Results of the current experiment proved that the addition of 5% moringa leaf meal improve fish growth while increasing this ratio led to decreasing in fish growth and increasing in feed conversion rate. Richter *et al*. (2003) in their preliminary laboratory feeding trials using Nile tilapia, *Tilapia niloticus* indicated that there was growth reducing effect at high levels (more than 50%) of inclusion of raw leaf meal of moringa. Dongmeza *et al*. (2006) reported a significant reduction in the growth performance of all fish fed diets containing 80% methanolic extract of moringa compared to the fish fed with the control diet. Ozovehe and Nzeh (2013) stated that fish fed 10% *M. oleifera* leaf meal diet recorded the highest value of specific growth rate and the growth and nutrient utilization by fish decreased as moringa leaf meal increased in the diets. Lemmens (2014) stated that diet contained 34.5% moringa meal as alternative protein source give lower growth criteria comparing with the Norwegian diet that contained 19.6% soybean meal as an alternative protein source. Puycha *et al*. (2017) proved that Bocourti's catfish (*Pangasius bocourti*) fed the diet containing moringa leaf at 100 g/kg appeared

better growth than at the other inclusion levels, but there was significant reduction in the growth performance as the moringa leaf inclusion increased in the diets.

Excessive consumption of plant protein sources by fish could cause slower growth rates and poor performance which may result in mortalities if the condition persists (Francis *et al.,* 2001). Richter *et al.* (2003) showed that higher substitution of *M. oleifera* leaf meal with the fish meal had an impact on lowering the growth performance because of the presence of anti-nutrients such as phenol, tannins, phytates and saponins. Presence of certain limiting factors in plant ingredients such as high crude fiber content and anti-nutritional factors have been demonstrated (Alegbeleye *et al.*, 2001; Nwanna *et al.,* 2008). Hlophe and Moyo (2014) stated that higher levels of anti-nutrients in moringa meal may be the cause of the adverse effects in growth criteria of *Clarias gariepinus,* and also stated that feeds were accepted at the start of the feeding trial, however, feed intake was significantly ($P<0.05$) reduced as the levels of moringa leaf meal in the diet increased.

Tilapia fed with a diet containing moringa leaf meal at 100 g/kg, 130 g/kg and 150 g/kg replacement with fishmeal-based dietary protein did not cause any adverse effect on growth performance (Richter *et al.*, 2003; Afung *et al.*, 2003). Yuangsoi and Masumoto (2012) worked on partial replacement of soybean meal not fishmeal with moringa leaf for common carp and proved that the tested moringa leaf diet contained ingredients that could be used with possibly not over 20 g/kg soybean protein replacement without negative effect on growth and digestibility. Ozovehe (2013) stated that juveniles *Clarias gariepinus* fed with the control diet did not show statistically significant ($P>0.05$) difference from fishes fed with 10% and 20% *M. oleifera* leaf meal diet in growth criteria. The results for the specific growth rate revealed that fish fed 40% *M. oleifera* leaf meal diet recorded the lowest value (Bello and Nzeh, 2013).

Bamidele *et al.* (2015) stated that moringa seed meal could replace soybean meal in the diet of *C. gariepinus* fingerlings at 75% inclusion level with little or no negative effect on the growth.

Karina *et al.* (2015) stated that the composition of moringa meal in the diets of the tilapia fingerlings did not have a significant effect on growth criteria, therefore, the recommended inclusion of moringa meal as a replacement to soybean meal is 16-32%. Richter *et al.* (2003) recommended a 30% substitution of moringa leaf meal for the diet of Nile tilapia. From the results of current experiment and most other researchers, we can conclude that moringa leaf meal can be used in low concentration (5-8%) as an ingredient of fish feed for common carp.

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استعمال مسحوق اوراق نبات المورنكا *Moringa oleifera* كبديل جزئي لمسحوق فول الصويا في غذاء اسماك الكارب الشائع

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الخلاصة

اجريت تجربة مختبرية لفحص استبدال مسحوق فول الصويا بمسحوق اوراق شجرة المورنكا (اسم العالم والسنة) *Moringa oleifera* (MLM) في الغذاء المصنع لاسماك الكارب الشائع *Cyprinus carpio*. استعملت ثمانية احواض زجاجية في مختبر الغذاء الحي لوحدة الاستزراع المائي في كلية الزراعة وبواقع مكررين لكل معاملة. استعملت اربعة معاملات مختلفة وهي معاملة السيطرة C(0% MLM) والمعاملة الاولى T1 (5% MLM) والمعاملة الثانية T2 (10% MLM) والمعاملة الثالثة T3 (15% MLM) لتغذية اسماك الكارب الشائع. استغرقت التجربة 56 يوم غذيت خلالها الاسماك ستة ايام في الاسبوع بنسبة تغذية قدرها 5% من وزن الاسماك. اثبت التحليل الاحصائي للزيادة الوزنية ومعدل النمو اليومي وجود فروقات معنوية بين المعاملة الثالثة وبقية المعاملات وعدم وجود فروق معنوية بين معاملة السيطرة وكل من المعاملة الاولى والثانية. افضل معدل تحويل غذائي (3.13) تم الحصول عليه من الاسماك في المعاملة الاولى التي غذيت على عليقة تحتوي 5% من مسحوق اوراق نبات المورنكا، بينما أسوأ معدل تحويل غذائي (7.50) تم الحصول عليه من الاسماك في المعاملة الثالثة التي غذيت على عليقة تحتوي 15% من مسحوق اوراق نبات المورنكا. ممكن ان نستنتج من نتائج التجربة الحالية ان افضل نمو ومعدل تحول غذائي تم الحصول عليه من قبل الاسماك التي غذيت على عليقة تحتوي 5% من مسحوق اوراق نبات المورنكا، وان زيادة هذه النسبة تؤدي الى نتائج سلبية في مؤشرات النمو.

الكلمات المفتاحية: الاحواض الزجاجية، الزيادة الوزنية، معدل النمو اليومي، معدل التحويل الغذائي