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Rapeseed meal as an alternative protein source in the diet of GIFT tilapia cultured in cages in reservoir

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ABSTRACT

Evaluation of the efficiency of rapeseed meal (RSM) as an alternative protein source by replacing soybean meal (SBM) in the diets of GIFT strain of Nile tilapia *Oreochromis niloticus* was carried out in cages installed at Poondi Reservoir, Tamil Nadu, South India. Five isonitrogenous (30% protein) and isolipidic (7% lipid) diets were formulated by incorporating RSM protein by replacing SBM at 0 (control diet), 25, 50, 75 and 100% levels (0RSM, 25RSM, 50RSM, 75RSM and 100RSM). Each diet was fed to two replicate groups of GIFT tilapia with a mean initial weight of 20.38 ± 0.07 g for 60 days in cages. GIFT tilapia fishes fed with 75RSM diet attained maximum percentage weight gain (PWG 590.89 %), maximum specific growth rate (SGR 3.22), best feed conversion ratio (FCR 1.03) and maximum protein efficiency ratio (PER 3.23) among the treatments. The fishes fed with 0RSM, 50RSM and 100RSM diets showed no significant difference ($p>0.05$) in mean weight gain (MWG), SGR, FCR and PER. No significant difference in hepatosomatic index (HSI) was found among the fishes fed with 0RSM, 75RSM and 100RSM diets. There was no significant difference ($p>0.05$) observed in survival between treatments. The whole body proximate composition (moisture, protein, lipid and ash) of GIFT tilapia did not differ significantly ($p >0.05$) among the treatments. It was concluded that, rapeseed meal can completely (100%) replace soybean meal protein in the diets of cage cultured GIFT tilapia in reservoir, without compromising growth, FCR and whole body composition.

Keywords: Cages, DL-methionine, GIFT tilapia, Rapeseed meal, Soybean meal, Survival

Introduction

World inland aquaculture presently contributes 51.4 million t (2016) of fish annually and finfish farming still dominates inland aquaculture, accounting for 92.5% (47.5 million t) of total production from inland aquaculture (FAO, 2018). Though various culture practices are available, freshwater aquaculture in India mainly depends on pond-based systems. Considering the ever increasing and ever conflicting cross-sectoral demands for water and land, there are limitations for growth in pond based aquaculture. Culture of fish in enclosures such as cages and pens installed in open water bodies offer scope for increasing production obviating the need for more land based fish farms.

A well documented effort in tilapia genetic improvement is the development of genetically improved farmed tilapia (GIFT), in Asia by the World Fish Centre (Ponzoni, 2008). The line was developed by crossing eight strains of *O. niloticus* followed by combined family and mass selection for body weight. Field trials demonstrated that the first generation GIFT tilapia line yielded 18 -58% larger fish compared with local strains of *O. niloticus*. The coefficient of variation (CV) for harvest weight in GIFT or Nile tilapia in general is around 40 to 60% (Ponzoni *et al*., 2005; Nguyen *et al*., 2007; Khaw *et al*., 2010), which is considered large. GIFT tilapia is known to be a fast growing strain of *O. niloticus,* which is widely used in a variety of culture systems in Asia (Dey *et. al*., 2000). Ng and Hanim (2007) reported that growth was influenced by the interaction between diet and tilapia genotype and feed conversion ratios were 14 and 33% better in GIFT tilapia compared to red tilapia fed 25 or 35% protein diets respectively. Promoting GIFT tilapia culture can have enormous benefits for the growing aquaculture industry of world's top most fish producing countries like India.

Soybean meal (SBM) is a widely available protein source with nearly sufficient digestible protein, high energy content, good amino acid profile (Hertrampf and Piedadu-Pascual, 2012) and used as a cost effective feed ingredient to replace fish meal in aquafeeds (Yue and Zhou, 2008). Increase in the use of SBM results in steady increase in its cost. Rapeseed meal (RSM) is a major protein source (a little less than 40% protein), that can be used as a feed ingredient for livestock, poultry and fishes. RSM is relatively less costly than soybean meal and the amino acid content of RSM is comparable e with that of SBM and richer in methionine (Clandinin, 1967).

In India, the market price of tilapia is less than that of other freshwater fishes such as carps and murrels. Sustainable production of tilapia is possible only if farmers get more profit. The costs of pelleted feeds available in the market need to be reduced to achieve a good profit. The present study focused on replacing relatively costly SBM with cost effiective RSM. So far no work has been carried out on the nutritional aspects of GIFT tilapia cultured in cages in India. In this context, the present study was aimed to replace SBM with RSM to develop cost efficient feed for cage reared GIFT tilapia.

Materials and methods

GIFT tilapia juveniles were procured from the State Fisheries Department, Krishnagiri, Tamil Nadu, India. Before the initiation of the feeding trial, fish fingerlings were acclimated in GI framed cages (6 × 6 × 4 m^3, having 144 l capacity each) for 2 weeks by feeding a commercial diet (11.5% moisture, 32% crude protein, 5% crude lipid and 4% crude fibre). Average water temperature recorded during the acclimation period was 25.5±1.15^{0}C.

Preparation of experimental diet

RSM for the experiments was procured from Mahendra Feeds Pvt. Ltd., Namakkal, Tamil Nadu, India. The meal was finely pulverised using the pulveriser available at Directorate of Incubation and Vocational Training in Aquaculture, Muttukadu, Tamil Nadu and passed through 80 µ mesh sized sieve. The control diet (0RSM) was formulated without addition of RSM, and four treatment diets were formulated with inclusion of RSM to replace SBM at 25, 50, 75 and 100% and designated as diet 25RSM, 50RSM, 75RSM and 100RSM, respectively. The amino acid profiles of all the formulated feeds were estimated and feeds were supplemented with limiting amino acids (lysine and methionine) to balance the required level for Nile tilapia recommended by NRC (2011). The major feed ingredients were sieved through 350 µm die, homogeneously mixed and then extruded in an extruder (Unitech, New Delhi, India) through 2 mm die. The resultant floating pellets were dried and stored in air-tight packets. Proximate and amino acid composition of feed ingredients are given in Table 1. Composition of experimental diets and amino acid content of formulated diets are given in Table 2 and 3 respectvely.

Experimental design for feeding trial

Experiment was conducted in 1 m^3 (1 m × 1 m × 1 m) sized cages installed in the Poondi Reservoir, Thiruvallur District. The high density poly-ethylene (HDPE) ropes and wooden frames were used to maintain the square shaped nylon meshed cages. Ten cages were used for the experiment. The stocking density was 50 nos. of juvenile GIFT tilapia per cage with a mean weight of 20.38±0.07 g. Feeding trial was conducted with five diets, *viz.,* 0RSM, 25RSM, 50RSM, 75 RSM and 100RSM. Each diet was fed to two replicate fish cages. The GIFT tilapia juveniles were fed thrice a day at 8.00, 12.00 and 16.00 hrs. Feeding was done as per NFDB (2016) for 60 days. The fishes were weighed every fortnight and the amount of feed adjusted accordingly.

Water quality analysis

The samples for water quality parameters were taken at fortnightly intervals between 10.00 to 10.30 hrs. Temperature, dissolved oxygen, hardness, alkalinity, ammonia, nitrite and nitrate were recorded (APHA, 1980). pH and dissolved oxygen levels were measured using pH meter (1100, EUTECH-Instruments, Singapore) and DO meter (HANNA, Taiwan) respectively.

Fish growth assessment

At the beginning and end of the feeding trial (60 days), fish were weighed after 1 day of feed deprivation. Feed conversion ratio (FCR), specific growth rate (SGR) and percentage survival rate were calculated as per standard procedures and formulae:

Mean feed intake (MFI) (g)	=	Total feed consumed (g)/ [Initial no.of animals + Final no. of animals/2]
Mean weight gain (MWG) (g)	=	Final body weight –Initial body weight
Percentage weight gain (PWG) (%)	=	[(Final body weight –Initial body /Initial body weight] X100
Food conversion ratio (FCR)	=	[Wet weight gain (g)/ Total feed consumed (g)] X100
Food conversion efficiency (FCE)	=	[Wet weight gain (g)/ Total feed consumed (g)] X100
Specific growth rate (SGR) (%)	=	[(ln final mean weight – ln initial mean weight)/No. of days] × 100
Protein efficiency ratio (PER)	=	Wet wet gain (g)/Protein ingested (g)
Average daily growth (ADG)	=	Mean final weight – Mean initial weight/Days of culture
Percentage of survival (%)	=	(No. of animals survived at the end of experiment/No. of animals stocked at the start of experiment) ×100
Hepatosomatic Index (HSI)	=	[Weight of liver/Weight of the fish] x100

Proximate analysis

At the beginning of the feeding trail, 10 fishes were sacrificed for whole body proximate analysis. At the end of the experiment, 6 fish from each cage were sacrificed for whole body proximate analysis and for determination hepatosomatic index (HSI). The moisture, crude protein, lipid, ash, fiber, nitrogen free extract (NFE) and gross energy of experimental diets and whole body of the fishes were analysed according to standard procedure (AOAC, 1995). Moisture was determined by oven drying at 105-110ºC for 6 h and protein by Micro Kjeldhal method after acid digestion. Lipid was determined by Soxhlet method by extracting in ether which is continuously volatilised at 60-80ºC. Crude fiber was estimated by dried fat free residues after digestion with dilute acid (0.255N) and alkali (0.313N). Ash was determined by ignition at 600ºC for 6 h in a muffle furnace. Gross energy (GE) was estimated using Digital Bomb Calorimeter (Model No. RSB, Rajdhani Scientific Inst. Co. New Delhi, India).

Statistical analysis

Oneway analysis of variance (ANOVA) was carried out to find out significant difference among the treatments. Tukey's multiple range tests was used to compare between treatment means. The data were statistically analysed by SPSS 20.0 for windows (SPSS Inc., Chicago, IL, USA).

Results

Growth performances and feeding efficiency

GIFT tilapia fed with 75RSM diet recorded maximum weight gain (120.45 g) compared to fish fed control and other treatment diets. However, it was not significantly different ($p>0.05$) from 0RSM, 50RSM and 100RSM fed groups of GIFT tilapia. Maximum SGR (3.22) attained by GIFT tilapia fed with 75RSM diet was significantly different ($p < 0.05$) from all other groups of fishes (Table 4).

GIFT tilapia fed with 75RSM diet showed best FCR (1.03) and poorest FCR was recorded in fish fed with 25RSM (1.29), which was not significantly different ($p> 0.05$) from the FCR recorded in fish fed with 0RSM, 50RSM and 100RSM diets. The maximum PER was recorded in fish fed with 75RSM diet (3.23), although it was not significantly ($p>0.05$) different from the PER attained by the fish fed with 0RSM, 50RSM and 100RSM diets. The lowest PER was found in the fishes fed with 25RSM (2.56), which was not significantly different ($p>0.05$) from PER recorded in fish fed 0RSM, 50RSM and 100RSM.

Average daily growth (ADG) of fish fed 75RSM (2.00 g), was significantly ($p < 0.05$) different from control and all other treatments. Minimum ADG (1.64) was recorded in the fishes fed with 25RSM diet, which was not significantly different ($p>0.05$) from the groups of fish fed with 0RSM, 50RSM and 100RSM diets. Mean feed intake was noted highest (139.83 g) in the groups of fishes fed with 100RSM. However, it was not significantly different ($p>0.05$) from mean feed intake recorded in the groups of fishes fed with all other RSM incorporated diets (25RSM, 50RSM and 75RSM) and control diet (0RSM).

Highest HSI was recorded in the group of fishes fed with diet 50RSM (2.56), though it was not significantly different ($p>0.05$) from the HSI recorded in the group of fishes fed with diets 0RSM and 75RSM. Though least HSI (2.22) was recorded in 25RSM diet fed GIFT tilapia, it was

Table 1. Proximate and amino acid composition of feed ingredients (% of dry weight)

Ingredients	Fish meal	Soybean meal	Rapeseed meal	Maize flour	Wheat flour
Moisture	8.96	7.63	10.04	9.8	11.74
Protein	63.28	48.7	37.9	8.29	10.05
Lipid	6.89	1.99	2.1	4.37	1.56
Ash	20.18	7.75	6.47	1.89	1.69
Fibre	3.7	7.06	11.15	2.78	1.6
Gross Energy (Kcal kg^{-1})	4254	4297	4079	3907	3714
Amino acid content of the ingredients (% of dry matter)					
Arginine	6.2	7.4	6.0	4.5	4.7
Histidine	2.4	2.6	2.6	2.8	2.3
Isoleucine	4.2	4.6	4.0	3.5	3.4
Leucine	7.2	7.5	6.8	12.0	6.5
Lysine	7.5	6.1	5.5	3.1	2.9
Methionine	2.7	1.4	2.0	2.1	1.6
Phenylalanine	3.9	5.0	3.9	4.8	4.5
Threonine	4.1	3.9	4.3	3.6	2.9
Tryptophan	1.0	1.3	1.2	0.7	1.2
Valine	4.9	4.8	5.1	4.8	4.3

Table 2. Composition of experimental diets (% of dry weight)

Ingredients	Formulated feeds				
	0RSM	25RSM	50RSM	75RSM	100RSM
Soy bean meal[1]	24.64	18.48	12.32	6.16	0
Fish meal[1]	21.33	21.8	22.5	22.8	23.0
Rapeseed meal[2]	0	7.9	15.83	23.74	31.66
Maize flour[1]	33.15	34.13	34.33	34.46	34.54
Wheat flour[1]	14.0	10.88	8.35	6.3	4.34
Palm oil[1]	3.16	3.13	3.08	3.05	3.02
Vitamin/mineral mix[3]	1.88	1.88	1.88	1.88	1.88
Vitamin C[3]	0.12	0.12	0.12	0.12	0.12
L-Lysine[4]	0.44	0.44	0.39	0.36	0.35
DL-Methionine[5]	1.28	1.24	1.2	1.13	1.09
Total	100	100	100	100	100
Proximate composition of feeds					
Moisture	9.7	9.65	9.19	9.82	9.56
Protein	32.7	32.36	32.32	31.41	30.52
Lipid	6.56	6.94	6.4	6.86	7.1
Ash	8.39	8.58	8.99	9.37	9.63
Fibre	1.25	1.64	1.76	1.57	2.06
Gross energy (Kcal kg^{-1})	4173	4183	4155	4125	4123

[1] Hakita Feeds Pvt. Ltd., Pondicherry, India; [2] Mahindra Feeds Pvt. Ltd., Namakkal, Tamil Nadu, India; [3] Anicare, Chennai, India
[4] Ajinomoto Heartland, Inc., Chicago; [5] Evonik AG, Germany

Table 3. Calculated dietary amino acid content of formulated feeds used in the experiment

Essential amino acids	Requirement of Nile Tilapia[1]	% Dietary protein				
		0RSM	25RSM	50RSM	75RSM	100RSM
Arginine	4.20	5.12	5.21	5.26	5.33	5.39
Histidine	1.72	2.53	2.46	2.41	2.37	2.33
Isoleucine	3.11	3.58	3.61	3.65	3.68	3.74
Leucine	3.39	8.25	8.34	8.41	8.48	8.56
Lysine	5.12	5.12 (4.68[a]+0.44[b])	5.12 (4.68[a] +0.44[b])	5.12 (4.73[a] +0.39[b])	5.12 (4.76[a] +0.36[b])	5.12 (4.77[a] +0.35[b])
Methionine	3.21	3.21 (1.93[c]+1.28[d])	3.21 (1.97[c] +1.24[d])	3.21 (2.01[c] +1.20[d])	3.21 (2.08[c] +1.13[d])	3.21 (2.12+1.09[d])
Phenylalanine	5.54	4.12	4.15	4.18	4.22	4.25
Threonine	3.75	3.42	3.47	3.52	3.57	3.62
Tryptophan	1.00	0.98	0.96	0.93	0.91	0.89
Valine	2.80	4.81	4.86	4.92	4.99	5.04

[1]Santiago and Lovell (1988), Amino acid requirements for growth of Nile tilapia; [a] Calculated lysine amount in the experimental feed without supplementation of L-Lysine; [b] Supplied L-Lysine amount in the feed; [c] Calculated methionine amount in the experimental feed without supplementation of DL-Methionine; [d] Supplied DL-Methionine amount in the feed

not significantly ($p>0.05$) different from the HSI values recorded from the groups of fishes fed with diets 0RSM, 75RSM and 100RSM. Survival showed no significant difference among the diets and it ranged from 98 to 100% among the treatments.

Whole body chemical composition

At the end of the experiment, it was observed that GIFT tilapia fed with control and RSM incorporated diets showed no significant difference in moisture, protein, lipid and ash content in whole body analysis (Table 5). Similarly, no significant difference ($p>0.05$) was observed in the initial and final proximate composition.

Discussion

In the present investigation, the growth experiment was conducted using RSM protein to replace SBM protein gradually, in the diets of GIFT tilapia. Similar kind of experiment was conducted by Davies *et al*. (1990), Lim and Klesius (1998) and Plaipetch and Yakupitiyage (2014) by using RSM protein to replace SBM protein in the diets of *O. niloticus*. Many researchers have utilised RSM as an alternative plant protein ingredient in fishes and have found different results with regard to growth performances and the feed utilisation (Yurkowski *et al*., 1978; Hardy and Sullivan, 1983; Hilton and Slinger, 1986; Leatherland

Table 4. Growth performance and feed utilization of GIFT tilapia fed experimented diets

Treatment	Mean initial weight (g)	Mean final weight (g)	Mean weight gain (g)	PWG (%)	SGR	PER	FCR	FCE	ADG (g)	Meanfeed intake (g)	HSI	Survival (%)
0RSM	20.45±0.91	125.89 ^{b}± 20.82	105.43^{ab}± 19.91	515.39^{c}± 21.87	3.02b±5.21	2.92^{ab}±3.53	1.13^{ab}±0.94	87.75^{ab}±1.06	1.75^{b}±0.33	129.46^{a}±0.19	2.30^{ab}±0.01	100
25RSM	20.32±0.85	119.02^{b}± 21.74	98.70^{b}± 20.88	485.66^{bc}± 24.45	2.94^{b}±5.39	2.56±3.34	1.29^{a}±0.99	76.96^{b}±1.03	1.64^{b}±0.34	138.80^{a}±0.21	2.22^{b}±0.01	98±2.0288
50RSM	20.43±0.87	122.47^{b}± 28.04	102.04^{ab}±27.16	499.4^{ab}± 31.03	2.98^{b}±5.77	2.85^{ab}±4.8	1.16^{ab}±0.69	85.74^{ab}±1.44	1.70^{b}±0.45	128.53^{a}±0.19	2.56^{a}±0.04	98±2.0165
75RSM	20.38±0.9	140.83^{a}± 34.37	120.45^{a}± 33.47	590.89^{a}± 36.93	3.22^{a}±6.05	3.23^{a}±5.58	1.03^{b}±0.59	96.93^{a}±1.67	2.00^{a}±0.55	132.67^{a}±0.22	2.42^{ab}±0.15	100
100RSM	20.35±0.9	140.83^{a}± 34.37	104.33^{ab}±30.89	512.60^{bc}± 34.04	3.02^{b}±5.92	2.68^{ab}±3.77	1.24^{ab}±0.88	80.43^{ab}±1.13	1.73^{b}±0.51	139.83^{a}±0.28	2.24^{b}±0.06	100
pValue	0.861	0.001	0.001	0.001	0.001	0.043	0.001	0.001	0.001	0.001	0.046	0.001

Table 5. Initial and final whole body proximate composition of experimental fishes (% of wet weight)

Treatment	Moisture	Protein	Lipid	Ash
Initial	71.38±0.15	16.74±0.08	6.46±0.04	4.41±0.02
0RSM	72.41±0.14	16.46±0.07	5.34±0.05	4.23±0.03
25RSM	72.33±0.16	16.66±0.09	5.41±0.03	4.59±0.04
50RSM	72.37±0.17	16.28±0.06	5.79±0.05	4.47±0.03
75RSM	72.53±0.14	16.52±0.07	5.28±0.04	4.22±0.04
100RSM	72.44±0.16	16.46±0.08	5.83±0.05	4.64±0.02
pValue	0.515	0.843	0.629	0.889

et al., 1987; Davies *et al*., 1990; Gomes *et al*., 1993; Higgs *et al*., 1995; Lim *et al*., 1997; Webster *et al*., 1997; Yue and Zhou, 2008).

RSM as a potential substitute for fish meal has been the subject of numerous studies with rainbow trout (Yurkowski *et al*., 1978; Hilton and Slinger, 1986; McCurdy and March, 1992; Gomes *et al*., 1993), chinook salmon (Higgs *et al*., 1982), tilapia (*Oreochromis mossambicus*) (Jackson *et al*., 1982; Davies *et al*., 1990), channel catfish (Webster *et al*., 1997) and Pacific white shrimp (*Penaeus vannamei*) (Lim *et al*., 1997). Among the RSM included diets, the best FCR was observed in 75RSM diet fed fishes (1.03), which was not significantly different from 0RSM, 25RSM and 100RSM. Similar results were recorded in replacing SBM with plant ingredients (Dorsa *et al*., 1982; Robinson and Daniels, 1987; Lim *et al*., 1998; Barros *et al*., 2002; Zhou and Yue, 2010; El-Saidy and Saad, 2011; Plaipetch and Yakupitiyagez, 2014). Davies *et al*. (1990) and Yue and Zhou (2008) concluded that, higher inclusion level of RSM and cottonseed meal (CSM) respectively, significantly affects FCR in fishes.

Mean weight gain (MWG) and protein efficiency ratio (PER) were observed highest in GIFT tilapia fed with 75RSM diet, though it was not significantly different from fishes fed with 50RSM and 100RSM diets. According to Plaipetch and Yakupitiyagez (2014), fermented RSM inclusion upto and over 75% of the SBM replacement level, showed reduced PER and significantly varied with control diet and lower levels of inclusion. Similarly, retarded PER was observed by Yue and Zhou (2008) in juvenile hybrid tilapia (*O. niloticus* x *O. aureus*) and Davies *et al*. (1990) in *O. mossambicus*. However, PER was found unaffected in higher inclusion level of plant protein in replacement of SBM (Yue and Zhou, 2008; El-Saidy and Saad, 2011). Average daily growth was observed highest in 75RSM diet, which was significantly higher than that for other diets in the present growth experiment. Plaipetch and Yakupitiyagez (2014), found no significant difference in daily weight gain among Nile tilapia fed diets with fermented RSM replacing SBM in diets, at all replacement levels.

Mean feed intake was recorded highest in 100RSM (139.83 g), and no significant difference was observed among other treatments. Similar results were observed for replacement of SBM with fermented RSM (Plaipetch and Yakupitiyagez, 2014), with CSM in Nile tilapia (El-Saidy and Saad, 2011) and channel catfish (Robinson and Li, 1994). On the contrary, Davies *et al*. (1990) observed declining level of feed intake with increasing level of RSM replacement in tilapia (*O. mossambicus*) diet.

In the present study, the survival of the GIFT tilapia was not significantly ($p>0.05$) affected by different levels of RSM inclusion. Similar trends of experimental fish survivability was observed in replacement studies of SBM with CSM in channel catfish (Robinson, 1991; Barros *et al*., 2002), juvenile hybrid tilapia (Yue and Zhou, 2008) and mono sex male Nile tilapia (El-Saidy and Saad, 2011).

In the present study, diet with 75% RSM protein replacement upon SBM protein showed significantly higher MWG and PER than other diets including control diet, with good FCR of 1.03. However previous studies have concluded that, RSM can be incorporated in the diets of hybrid tilapia upto a level of 19.02%, which can replace 30% protein of SBM, without significant negative effects on growth performance and feed utilisation (Zhou and Yue, 2010). Weight gain, SGR and PER of juvenile hybrid tilapia were significantly retarded at replacement levels exceeding 30% of SBM with RSM. Davies *et al*. (1990) reported that only 15% RSM could effectively replace SBM in tilapia (*O. mossambicus*) diets. Similar results were also observed in rainbow trout (Yurkowski *et al*., 1978; Hardy and Sullivan, 1983; Hilton and Slinger, 1986; Leatherland *et al*., 1987; Gomes *et al*., 1993). Jackson *et al*. (1982) found decrease in growth rates in *O. mossambicus* when 75% FM protein was replaced by RSM and indicated that it may have been due to the toxic effects of glucosinolates.

Inadequate essential amino acids (especially, lysine and methionine) could be the main reason that causes negative growth performances in fish fed higher RSM included diets (Enami, 2011). In this present study, limiting amino acids *viz.,* methionine and lysine were considered during the formulation of experimental diets. Tacon and Metian (2008) reported that the growth performance of Nile tilapia was improved when 0.8% DL-methionine was supplemented to a diet in which 75% of fish meal was replaced by SBM. These results are in agreement with the present study, which reported that weight gain of juvenile GIFT tilapia increased significantly as methionine levels increased by supplementation of crystalline methionine, indicating that juvenile GIFT tilapia could use crystalline methionine efficiently when supplemented in practical diets. The experiment pertaining to the evaluation of alternative plant protein source, concluded that, RSM can completely (100%) replace SBM protein in the diets of GIFT tilapia reared in cage installed in reservoir. RSM could be incorporated at a level of 31.66% in diets of GIFT tilapia which corresponds to a complete exclusion of SBM at a level of 24.64% in the control diet without compromising growth, FCR and whole body composition.

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