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Sunflower meal as an alternative protein source to replace soybean meal in the diet of GIFT strain of Nile tilapia *Oreochromis niloticus*

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ABSTRACT

The main objective of the study was to investigate the effect of partial replacement of soybean meal (SBM) protein with sunflower meal (SFM) protein on growth performance, feed utilisation, survival and body composition of GIFT tilapia. Fish weighing between 1.03±0.01 and 1.19±0.02 g were stocked in plastic troughs (50 l) at a stocking rate of 15 fishes per trough. Percent replacement of SBM by SFM on the basis of crude protein was 0% (control), 10% (SFM10), 20% (SFM20) and 30% (SFM30). Diets were fed to fish at the rate of 5% of the total fish biomass, daily for a period of 60 days. Fish fed with SFM 20% and SFM 30% sunflower meal had best performance in terms of weight gain, specific growth rate, protein efficiency ratio, feed efficiency ratio and feed conversion ratio ($p<0.05$). Analysis of fish whole body composition revealed that with increasing dietary SFM levels, whole body protein, ash and moisture contents showed significant difference among dietary treatments ($p<0.05$). Fish fed with SFM 30 diet showed the best growth performance compared to fish fed with the control diet.

Keywords: GIFT tilapia, Growth, Soybean meal, Sunflower meal, Whole body composition

Introduction

Aquaculture is the fastest growing food sector and its economic significance is increasing concomitantly (FAO, 2009) with production also rapidly increasing worldwide (FAO, 2016). Aquaculture, especially of tilapias, has the potential to play a leading role in the fight to eradicate food insecurity, malnutrition and poverty (Bene and Heck, 2005). Tilapia is the second most cultured fish globally and its production has quadrupled over the past decade because of its suitability for aquaculture, marketability and stable market prices (Wang *et al.,* 2016). Feed is one of the major and important inputs in aquaculture production and high cost of fish feed is one of the major problems hindering aquaculture development (Tiamiyu *et al.,* 2013). Soybean meal is a preferable alternative ingredient to fish meal in the diet of tilapia. However, its cost is a hurdle for fish nutritionists to produce cost effective tilapia feed. Sunflower meal is easily available, has good nutritional profile and can become a better alternative protein source to fish meal and soybean meal in the diet of tilapia. In India currently, sunflower ranks fourth among the oilseed crops in terms of acreage and production (Inturrisi, 2015). Commercial production started in the early 1970s, with a low 15,000 ha area, peaking to 2,339,000 ha in 2005 with a production of 1.4 million t of seed. The top producers are the states of Karnataka and Andhra Pradesh in the southern zone, Maharashtra in the central zone, Gujarat in the western zone, and Punjab in the northern zone (Department of Agriculture and Cooperation, Govt. of India, 2013). In the year of peak production (2005), India accounted for almost 10% of the world's sunflower area harvested and 4.8% of production (Inturrisi, 2015).

Sunflower meal is a rich source of protein for fishes, specially in its winnowed form. It is frequently applied to substitute soybean meal since it is free of trypsin inhibitors and has abundant vitamin content than soybean meal (Hertrampf and Piedad-Pascual, 2000). Protein content of sunflower meal ranges from 29 to 33% for non-dehulled meals and 35 to 39% for dehulled and partially dehulled meals (Heuze *et al.,* 2015). The present study, investigated the efficiency of replacement of soybean meal (SBM) with sunflower meal (SFM) as a protein source in the diet of GIFT tilapia.

Materials and methods

Experimental fish

GIFT tilapia weighing between 1.03±0.01 and 1.19±0.02 g were procured from the State Fisheries Department, Krishnagiri, Tamil Nadu, India. The seeds were acclimatised for 15 days in an indoor fibre glass tank (4 m x 10 m x 1.5 m) and fed with commercial pelleted feed *ad libitum* prior to feeding trials. Feeding trials were carried out in the wet laboratory at Advance Research

Farm Facility (ARFF), Madhavaram, Tamil Nadu, India. Experimental setup consisted of 12 plastic troughs (50 l capacity) each filled to three-quarter (¾) of its volume with water from a borewell. In order to prevent fish escaping from culture troughs, the troughs were covered with plastic net on top. The system was static and fully aerated for oxygen supply through electric aerators indoor during the 60 days of culture period.

Experimental diet and feeding

The selected feed ingredients were subjected to proximate composition analysis following standard procedures (AOAC, 2005). For the feeding trials, four sets of isonitrogenous and isoenergetic experimental diets were formulated by replacement of SBM by SFM on the basis of crude protein at 0% (control), 10% (SFM10), 20% (SFM20) and 30% (SFM30) levels. The ingredient composition of experimental diets is shown in Table 1. Proximate composition of feed ingredients and experimental diets were analysed as per AOAC (2005). Feeding was done twice a day between 09.00 - 10.00 hrs and 15.00 - 16.00 hrs at a feeding rate of 5% body weight per day for entire duration of feeding trial (60 days).

Water quality parameters

Water quality parameters such as temperature, dissolved oxygen, pH, hardness and total alkalinity were measured and recorded daily. Standard analytical methods as per APHA (2005) were employed for estimation of the various physico-chemical parameters which included total ammonia-N, nitrite-N, nitrate-N, water hardness which were assessed twice a week.

Sampling and growth performance

Sampling was done once in every 15 days for 60 days. Total length and body weight of all stocked fish in each trough were measured for estimation of growth parameters and feed utilisation. Growth performance was examined in terms of live weight gain (LWG), feed conversion ratio (FCR), specific growth rate (SGR%), protein efficiency ratio (PER), feed efficiency ratio (FER), apparent net protein utilisation (ANPU), energy retention (ER), survival rate and mean weight gain which were calculated according to Prabu *et al.* (2018).

Data analysis

One way analysis of variance (ANOVA) was used to determine differences between treatment means which were considered significant at $p<0.05$. *Post-hoc* analysis was done when significant differences were found between treatment means, using Tukey's Honest significant difference test (Steele and Torrie, 1980). Analyses were performed using SPSS software version 16.0 for windows (SPSS Inc., Chicago, USA).

Results

Water quality

Over the 60 days of feeding duration, no significant difference was observed in the water quality parameters recorded (Table 2), between the experimental treatments ($p>0.05$). The water quality parameters were within the acceptable range for the growth of the species (Stickney, 1979).

Proximate composition of experimental diets

Proximate composition of the candidate ingredients (SFM) and the experimental diets are shown in Table 3.

Growth performance of GIFT tilapia fed with SFM diets

Survival rate (SR) of each treatment was above 94% and results did not show significant difference between

Table 1. Ingredient composition of formulated feed

Ingredients	Percentage of inclusion			
	Control (C)	10% SFM	20% SFM	30% SFM
Soybean meal	46	36	26	16
Sunflower meal	0	10	20	30
Cassava starch	15	15	15	15
Fish meal	13	13	13	13
Corn flour	18	18	18	18
Fish oil	3	3	3	3
Di-calcium phosphate	2	2	2	2
Vitamin premix	1	1	1	1
Mineral premix	1	1	1	1
Salt	1	1	1	1

Composition of vitamin premix (Quantity per kg): Vit. A - 1,00,00,000 IU, Vit. B1 - 5,000 mg, Vit. B2 - 5,000 mg, Vit. B3 - 6,000 mg, Vit. B5 - 6,000 mg, Vit. B6 - 6,000 mg, Vit. C - 60,000 mg, Vit. D3 - 20,00,000 IU, Vit. E - 10,000 IU, Vit. H - 200 mg.

Composition of mineral premix (Quantity per kg): Magnesium - 2,800 mg, Iodine - 7.4 mg, Iron - 7,400 mg, Copper - 1,200 mg, Manganese - 11,600 mg, Zinc - 9,800 mg, Cobalt chloride - 4 mg, Potassium - 100 mg, Selenium - 4 mg, Calcium carbonate - 27.25%, Phosphorous - 7.45 mg, Sulphur - 0.7 mg, Sodium - 6 mg, Calpan - 200 mg, Aluminium - 1,500 mg and Choline chloride - 10,000 mg

Table 2. Water quality parameters (Mean ±SE) recorded during the experimental period

Parameters	Diets				
	SFM 10	SFM 20	SFM 30	C	p<0.05
Temp (ºC)	27.75±0.35 [a]	27.56±0.31 [a]	27.26±0.35 [a]	27.04±0.41 [a]	0.726
DO (mg l^{-1})	5.07±0.10 [a]	5.35±0.08 [a]	5.18±0.08 [a]	4.97±0.13 [a]	0.109
pH	7.48±0.11 [a]	7.32±0.13 [a]	7.35±0.11 [a]	7.45±0.12 [a]	0.948
NH_3-N (mg l^{-1})	0.002±4.3E-4 [a]	0.002±4.4E-4 [a]	0.002±3.3E-4 [a]	0.002±5.3E-4 [a]	0.648
NO_2-N (mg l^{-1})	0.05±0.01 [a]	0.06±0.02 [a]	0.06±0.01 [a]	0.06±0.02 [a]	0.999
NO_3-N (mg l^{-1})	0.031±4.4E-2 [a]	0.032±4.6E-2 [a]	0.032±4.5E-2 [a]	0.031±4.4E-2 [a]	1.000
Hardness (mg l^{-1})	116.22±5.29 [a]	121.78±6.34 [a]	119.78±5.37 [a]	107.78±9.02 [a]	0.490
Alkalinity (mg l^{-1})	90.22±6.52 [a]	87.78±6.59 [a]	77.33±6.15 [a]	85.11±6.26 [a]	0.847

[a] Different superscripts in the same row indicate significant difference (p<0.05)

Table 3. Proximate composition (%) of sunflower meal and experimental diets

Parameter	Diets				
	Sunflower meal	SFM 10	SFM 20	SFM 30	C
Moisture	11	9.60 ± 0.35	10.94 ± 0.02	11.77 ± 0.07	14.89 ± 0.09
Crude protein	32.4	30.98 ± 0.05	29.38 ± 0.02	28.96 ± 0.02	30.96 ± 0.02
Crude fibre	27.9	6.68 ± 0.03	7.65 ± 0.01	5.83 ± 0.01	2.95 ± 0.01
Crude lipid	2.2	4.44 ± 0.06	4.29 ± 0.05	4.52 ± 0.01	2.97 ± 0.04
Total ash	7.1	9.26 ± 0.11	9.02 ± 0.07	9.38 ± 0.17	9.06 ± 0.03
Gross energy (kcal kg^{-1})	4637	3999 ± 0.58	3959 ± 0.87	3939 ± 0.69	3715 ± 0.52

different dietary treatments (p>0.05) as shown in Table 4. The highest body mean weight was observed in fish fed with diets SFM 30% (24.90±0.89 g), followed by SFM 20% (24.03±0.29 g), SFM 10% (17.32±0.25 g) and control (13.37±0.15 g) (Fig. 1). Mean body weight of fish fed with SFM diets showed highly significant difference with those fed with control diet (p<0.05). The differences in feed consumption and growth led to significant differences in FER, SGR, FCR and PER (Table 4). The best FCR was exhibited in SFM 30% (1.11±0.01), followed by SFM 20% (1.20±0.03), SFM 10% (1.27±0.01) and control (1.3±0.03). The highest value of SGR was obtained in SFM 30% (5.28±0.02% day^{-1}), followed by SFM 20% (5.22±0.02% day^{-1}), SFM 10% (4.57±0.06% day^{-1}) and in control (4.17±0.02% day^{-1}). The inclusion levels of SFM from 20 to 30% had the best significant effect on FCR, FER, PER and SGR (p<0.05) (Table 4). The highest ANPU value was noticed in fish fed with SFM 10% diet (48.64±0.00) followed by diets SFM 20% (45.03±0.20), control (44.51±0.99) and SFM 30% (42.68±2.04). The value of ANPU was found to be inversely proportional to the increase in replacement levels of sunflower meal (Table 4).

Table 4. Growth performance and nutrient utilisation of GIFT tilapia fed with SFM diets (Mean±SE, n=3)

Parameter	Diets				
	SFM 10	SFM 20	SFM 30	C	p<0.05
IW (g)	1.24 ± 0.02[a]	1.03 ± 0.01[a]	1.19 ± 0.02[a]	1.18 ± 0.03[a]	0.215
FW (g)	17.32 ± 0.25[a]	24.03 ± 0.29[bc]	24.90 ±0.51[bc]	13.37 ± 0.15[d]	1.47E-7
LWG (g)	15.57 ± 0.55[a]	22.99 ± 0.29[bc]	23.72 ±0.50[bc]	12.19 ± 0.15[d]	7.90E-8
FI (g $fish^{-1}$ day^{-1})	0.32 ± 0.01[a]	0.45 ± 0.01[a]	0.44 ± 0.01[a]	0.26 ± 0.01[b]	1.17E-6
WMG (g $fish^{-1}$ day^{-1})	0.26 ± 0.01[a]	0.38 ± 0.01[bc]	0.39 ± 0.01[bc]	0.20 ± 0.00[d]	1.47E-7
SGR (% day^{-1})	4.57 ± 0.06[a]	5.22 ± 0.02[bc]	5.28 ± 0.02[bc]	4.17 ± 0.02[d]	6.79E-8
FCR	1.27 ± 0.01[a]	1.20 ± 0.03[bc]	1.11 ± 0.01[bc]	1.3 ± 0.03[a]	3.63E-5
PER	0.50 ± 0.02[a]	0.78 ± 0.01[bc]	0.82 ± 0.02[bc]	0.39 ± 0.00[d]	4.75E-8
FER (%)	0.79 ± 0.01[a]	0.83 ± 0.03[bc]	0.90 ± 0.01[bc]	0.77 ± 0.03[a]	6.80E-6
ANPU (%)	48.64 ± 0.00[a]	45.03 ± 0.20[ab]	42.68 ± 2.04[ab]	44.51 ± 0.99[a]	0.033
ER (%)	13.41 ± 0.25[a]	12.51 ± 0.62[a]	13.02 ± 1.62[a]	17.32 ± 0.02[ab]	0.017
SR (%)	95.56 ± 4.44[a]	97.78 ± 2.22[a]	95.55 ± 2.22[a]	93.33 ± 3.85[a]	0.827

[a, b,c,d]Different superscripts in the same row indicate significant difference (p<0.05). IW=Initial weight, FW=Final weight, LWG=Live weight gain, FI=Feed Intake, MWG=Mean weight gain, FCR=Feed conversion ratio, PER=Protein efficiency ratio, FER=Feed efficiency ratio, ANPU=Apparent net protein utilisation, ER=Energy retention, SR=Survival rate, C=Control, SFM=Sunflower meal, 10, 20 and 30=Percent inclusion level.

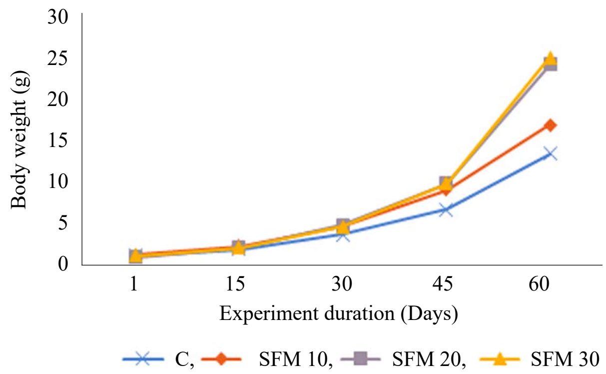

Fig. 1. Increase in body weight of GIFT tilapia fed with various levels of SFM incorporated diets during the experimental period

Whole body composition of GIFT tilapia fed with SFM diets

Analysis of fish whole body composition revealed that with increasing dietary SFM levels, whole body protein, ash and moisture contents showed significant difference among dietary treatments ($p<0.05$). Those fish fed control diet showed relatively higher values of energy retention compared to fish fed with SFM diets and were highly significant among the fish fed on SFM diets (Table 5). Crude protein level was found to decline with increment in incorporation level of sunflower in the diet.

Whole body amino acid analysis of fish fed with SFM diets

The whole body amino acid composition of fish fed with SFM diets are shown in Table 6. Indispensable and non-indispensable amino acids, increased up to 20% and began to decline at 30% of SFM inclusion levels except valine and proline which increased gradually with increment of SFM level in the diet. Quantity of glutamic acid was higher in 10% SFM incorporated feed when compared to 20 and 30% of SFM incorporated diets.

Dietary supplementation of SFM at different levels significantly ($p<0.05$) affected the whole body amino acid profile of GIFT tilapia. Indispensable and non-indispensable amino acids were found to be higher in fish fed with 10 and 20% SFM diets.

Discussion

The present study revealed that soybean meal protein can be replaced with sunflower meal protein in diets of GIFT tilapia fingerlings at 20 and 30% inclusion levels without compromising growth performances and feed efficiencies. The increased SFM levels from 10 to 30% in diets improved SGR, FER, FCR and PER. Optimum growth and feed utilisation was observed when SFM was included up to 30% level (Table 4). Results of the present study are in partial agreement with the findings of Olvera-Novoa *et al.* (2002), who found that Nile tilapia diets which contained 10 and 20% sunflower meal provided the best growth performance and feed efficiency. El-Saidy and Gaber (2002) showed that upto 50% dehulled sunflower meal protein can be used to replace fish meal as a protein source in the diet of Nile tilapia, *Oreochromis niloticus* without significant effect on weight gain. Fagbenro and Davies (2000) found that replacing 67% of fish meal by sunflower meal significantly ($p<0.05$) decreased weight gain of Nile tilapia. Abdul-Aziz *et al.* (1999) described the possibility of partial substitution of soybean protein by sunflower protein upto 50% without adverse effect on body weight of Nile tilapia fingerlings. Sanz*et al.* (1994) evaluated the nutritive potential of sunflower meal protein as compared to soybean meal and fish meal protein in trout diets and found that, sunflower meal protein could replace upto 40% of fish meal protein or soybean meal protein in the diet without any negative effect on fish body weight. In the present study, replacing soybean meal by sunflower meal in GIFT tilapia diet upto 30% inclusion level did not significantly affect SGR, FCR, FER and PER. Jackson *et al.* (1982) found that upto 25% of sunflower meal (*Helianthus annuus*) could replace fish meal protein without significant effect on the growth of Mozambique tilapia (*Oreochromis mossambicus*) under laboratory conditions. Olvera-Novoa *et al.* (2002) documented that redbreast tilapia (*Tilapia rendali*) fed with diets containing 10 and 20% sunflower protein source

Table 5. Whole body proximate composition of GIFT tilapia fed sunflower meal diets (%wet weight basis, mean ± SD, n=3)

Parameter	Diets					
	Initial (0)	SFM 10	SFM 20	SFM 30	C	p<0.05
Moisture (%)	$11.28±0.20^{a}$	$5.64 ±0.35^{b}$	$6.68±0.46^{b}$	$6.28±0.29^{b}$	$5.21±0.13^{bc}$	4.59E-7
Crude protein (%)	$54.00±0.23^{a}$	$69.07 ±0.23^{b}$	$67.23±0.29^{c}$	$66.36 ±0.44^{cd}$	$67.78±0.35^{bce}$	1.0E-10
Crude fibre (%)	$1.64±0.23^{a}$	Not found	Not found	Not found	Not found	0.004
Ether extract (%)	$16.60±0.29^{a}$	$14.57 ±0.29^{b}$	$15.40±0.35^{ab}$	$15.17±0.52^{ab}$	$16.39±0.19^{a}$	0.009
Total ash (%)	$15.25±0.14^{a}$	$11.12 ±0.12^{b}$	$11.82±0.23^{bc}$	$12.54±0.29^{cd}$	$11.28±0.23^{be}$	4.31E-7
Gross energy (kcal kg^{-1})	$4735±0.58^{a}$	$5279 ±0.69^{b}$	$5254±0.81^{c}$	$5183±0.58^{d}$	$5378±0.87^{e}$	2.1E-23

[a,b,c,d,e]Different superscripts in the same row indicate significant difference ($p<0.05$)

Table 6. Whole body amino acid composition (mg 100 mg^{-1}) of GIFT tilapia fed diets with different levels of SFM (Mean±SE, n=3)

Amino acids	Diets					
	Initial	C	SFM 10	SFM 20	SFM 30	p<0.05
Essential amino acids						
Arginine	1.754±0.0075^a	2.604±0.0023^b	2.892±0.0127^c	2.848±0.0034^d	2.628±0.0103^b	2.07E-15
Histidine	0.803±0.0017^a	0.909±0.0005^b	0.823±0.0066^a	0.588±0.0046^c	0.588±0.0103^d	7.02E-12
Isoleucine	1.423±0.0132^a	1.538±0.0103^b	1.992±0.0404^c	1.877±0.0155^d	1.694±0.0080^e	1.83E-8
Leucine	2.299±0.0109^a	2.969±0.0138^b	3.461±0.0178^c	3.258±0.0161^d	3.077±0.0127^e	8.76E-13
Lysine	2.098±0.0519^a	3.218±0.0103^b	3.597±0.0098^c	3.172±0.0115^b	3.256±0.0167^b	2.10E-11
Methionine	1.720±0.0635^a	2.047±0.0075^b	2.134±0.0178^b	2.253±0.0127^b	1.426±0.0092^c	1.88E-8
Phenylalanine	1.452±0.0063^a	1.664±0.0080^b	2.118±0.0057^c	2.078±0.0098^d	1.883±0.0075^e	1.25E-13
Threonine	1.565±0.0144^a	1.937±0.0040^b	1.984±0.0138^b	1.967±0.0051^b	1.952±0.0230^b	4.91E-9
Valine	1.712±0.0063^a	1.950±0.0288^b	2.245±0.0086^c	2.181±0.0461^c	2.577±0.0098^d	4.23E-9
Non-essential amino acids						
Aspartic acid	3.201±0.0115^a	4.644±0.0179^b	5.892±0.0184^c	5.100±0.0577^d	4.431±0.0173^e	3.61E-13
Glutamic acid	4.68±0.1096^a	5.996±0.0086^b	6.183±0.0190^b	5.799±0.0236^{bc}	5.473±0.0132^d	1.301E-8
Serine	1.454±0.0023^a	1.945±0.0057^b	2.254±0.0063^c	1.972±0.0127^b	1.901±0.0121^d	4.14E-13
Glycine	2.720±0.0115^a	3.882±0.0098^b	3.717±0.0080^c	3.998±000635^d	3.913±0.0069^b	9.25E-16
Alanine	2.300±0.1154^a	2.965±0.0086^b	3.010±0.0057^b	2.890±0.1270^b	3.038±0.0150^b	2.50E-4
Proline	1.857±0.0155^a	2.267±0.0040^b	2.1390±0.0121^c	2.172±0.0069^c	2.306±.0034^b	1.36E-10

$^{a, b, c, d, e}$ Different superscripts in the same row indicate significant difference (p<0.05)

and fish meal as the sole protein source exhibited similar growth performances and feed efficiencies. Bilguven and Baris (2011) reported similar growth performance in rainbow trout (*Oncorhyncus mykiss*) fed with either 65% sunflower meal or standard FM diets. However, Tahir *et al.* (2008) observed non-ideal growth performance of Indian major carps catla (*Catla catla*) and rohu (*Labeo rohita*) fed diets incorporating 20, 40 and 60% sunflower seed meal. The variation in results among the studies might be due to differences in diet composition, protein level and quality of plant feedstuff source used, culture conditions such as temperature and dissolved oxygen fluctuations, genetics of fish, species difference, quantity of amino acid required by fish, digestibility and age (size of fish).

Garcia-Gallego *et al.* (1998) demonstrated that, 100% replacement of fish meal with SFM and essential amino acids exhibited maximum growth performances and feed efficiencies compared to 50 and 100% fish meal replacement without essential amino acids supplementation. The essential amino acids have been added in 100% fish meal replaced diet in order to fulfil the optimum dietary amino acid requirement of fish.

Sanz *et al.* (1994) also obtained an improvement in the growth of rainbow trout when diets containing SFM protein were enhanced with leucine, lysine and methionine, with better results than diets containing fishmeal or SFM without enhancement. Results related to sunflower meal presented in Table 4 are also in agreement with the outcomes of Tacon *et al.* (1984), Martinez (1986) and Sanz *et al.* (1994) who reported that sunflower seed meal is known to be used successfully by trout at low level and by tilapia (Jackson *et al.,* 1982) at higher levels with the addition of methionine. Martinez (1986) completely substituted soybean meal with sunflower meal in trout diet and recommended that the replacement is without negative effects. The FCR (1.11±0.01; 1.20±0.03) and PER (0.78±0.01; 0.82±0.02) values obtained in the present study at SFM 20% and SFM 30% inclusion levels respectively, are better than those reported by El-Sayed (1998) (FCR = 1.86; PER = 1.55), which were obtained by using expensive animal proteins. The best FCR, FER and PER in this study were found with SFM 20% and SFM 30%. Abdul-Aziz *et al.* (1999) observed that, replacement of soybean meal by sunflower meal at 25 or 50% significantly affected FCR of Nile tilapia. Amino acid profile of carcass reflects the ideal protein pattern of given tissue and can be used to predict protein utilisation in many fish species (NRC, 2011). In this study, dietary supplementation of SFM significantly affected the whole body protein, ash and moisture contents in GIFT tilapia, which might be due to the changes in protein source in the dietary treatments. Similar to the results of this study, Prabu *et al.* (2019) observed significant differences in the whole body protein content of GIFT tilapia fed graded levels of DL-methionine supplemented diets. Infact, changes in the protein source as well as amino acid pattern of the diet also had great impact on the influence of whole body chemical composition. In the present study, amino acid availability generally reflected protein digestibility. Amino acid profile of whole body decreased with increasing SFM levels in the diets. In

European seabass, Spyridakis *et al.* (1988) found similar results with diets containing soybean meal. With regard to whole body amino acid composition of GIFT tilapia, Prabu *et al.* (2019) documented significant differences in whole body lysine, methionine and tryptophan. The study of Furuya *et al.* (2000) found that, increasing sunflower meal in tilapia diets bring a quadratic effect ($p<0.05$) on PER of Nile tilapia. Results of the present study revealed that incorporation up to 30% of dietary SFM protein could replace SBM protein in the diets of GIFT tilapia enabling better growth performance, feed utilisation and survival.

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