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Effect of Guar Sprout Meal on the Growth, Nutrient Utilization and Hematological Characteristics of Genetically Improved Farmed Tilapia (Gift) Fingerlings

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ABSTRACT

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The present study was carried out on the fingerlings of Nile tilapia (*Oreochromis niloticus*) to investigate the effect of 'Guar sprout meal (GSM)' as a potential protein replacement of fishmeal. The experiment was set in triplicate with five isonitrogenous and isolipidic containing guar sprout meal at an inclusion rate of 0, 25, 50, 75 and 100% respectively. The practical diets were fed to triplicate groups of 20 fingerlings with mean initial body weight 4.26 ± 0.02 g reared in circular FRP tanks of 100 L capacity at 5-7% of their body weight. The results indicated that animals performed well at 25% and 50% inclusion levels of GSM. However, the diet containing 25% GSM interestingly gave higher final weight and specific growth rate compared to other treatments and control diet. It was observed that there was a significant decrease in growth rate, SGR, FCR, PER and feed utilizations with increasing GSM levels beyond 50%. The percentage survival obtained was 100% with all the treatments. The results conclude that GSM at an inclusion at 25-50% can be a promising and economically sustainable source protein and fish meal replacement in the diet of Nile tilapia fingerlings.

Introduction

Fish meal is the major conventional feed ingredient widely used as a protein source in stock management because it offers a balanced source of indispensable amino acids, essential fatty acids, vitamins and minerals. However, in recent decades the emerging demand for fishmeal imposed a major constraint in aquaculture expansion owing to

declined availability, high competition in the market, unreasonable price levels and unbearable fusty odour during the manufacture. To overcome this bottleneck, researches explored towards an alternative protein sources especially from plant based products with equal nutritional values (Abdel-Fattah M *et al.*, 2016). Among the plant protein sources, guar meal is one of the potential non-conventional feedstuffs, and

with high ranking because of its abundant availability and satisfactory nutritional profile (Ahmed, 1998; Hussain *et al.*, 2012).

Guar, *Cyamopsis tetragonoloba* (L.) Taub, commonly called cluster bean, is a summer low-emission crop (Gresta *et al.*, 2014). It has an excellent drought tolerance ability and can be grown successfully in semi-arid regions with medium- sandy textured soil of many countries of the world (Whistler and Hymowitz, 1979; Tayagi *et al.*, 1982; Francois *et al.*, 1990; Hafedh and Siddiqui, 1998). It is mostly found in the North and North West of India and East and South East of Pakistan (Hussain *et al.*, 2012).

The plant can fix atmospheric nitrogen (Elsheikh and Ibrahim, 1999) and is tolerant to low fertility, salinity and alkalinity of soil. It is a relatively cheap meal containing reasonable amino acid profile and high protein levels of 33-60% (Couch *et al.*, 1967; Nagpal *et al.*, 1971; Abdel-Fattah *et al.*, 2016). Inclusion of GM in fish feed can be maximized by adopting proper processing techniques as it contains some anti-nutritional factors like trypsin inhibitor (Couch *et al.*, 1967), polyphenols (Kaushal and Bhatia, 1982), saponins (Thakur and Pradhan, 1975), galactomannan (Katoch *et al.*, 1971; Furuse and Mabayo, 1996) which limit its use. In some parts of the world, like other plant beans, guar is used as an animal and human food (Sharma *et al.*, 1984; Hassan *et al.*, 2008; Dinani *et al.*, 2010 and Pathak *et al.*, 2011).

The aim of the present study was to examine the possibility of using guar sprout meal to improve the nutritional quality of commercial fish feed and to evaluate the effect of same on the growth, nutrient utilization and hematological characteristics of genetically improved farmed tilapia (GIFT) fingerlings, *Oreochromis niloticus*.

Materials and Methods

Fish and culture protocol

A total of 300 monosex (all male) fingerlings of Nile tilapia (*Oreochromis niloticus*) were obtained from NETFISH MPEDA, Cochin which is the authorized supplier of GIFT seed in south India. Fish with an average weight of 4.26 ± 0.02 g were acclimatized for a week and stocked in triplicate groups at a density of 20 fish per FRP tank of 100 liter volume in the indoor facility of the Department of Aquaculture, KUFOS. The water was exchanged at the rate of 50 % on a daily basis in the morning hours while the excreta and leftover feed were removed by siphoning.

At the end of 60 days trial period, all fish from each tank were sampled to record the final mean weight, percentage gain in weight, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), condition factor percentage (CF%) and the survival rate were calculated (Table 2).

The germinated guar meal was prepared by soaking the whole seeds in distilled water (1:5 w/v) for 14-16 h at room temperature (26-28°C). Further, the seeds were shifted to a well-spaced tray with bottom sieves which is suitable for seeds to sprout 4-5 times their original volume. The soaked seeds were sprayed with calcium hypochlorite (1 tablespoonful CaOCl₂ in 13-14 liters water) to prevent the mold growth and were covered with moist clean cloth. During the germination period the container was kept in a moist dark place for 1-1^{1/2} days where the temperature range maintained between 22-27°C. After the end of the process, the germinated seeds were dried, pulverized, sieved, and finally stored in an airtight container at room temperature in a dry place for diet preparation.

Diets and feeding

Five pelleted isonitrogenous and isolipidic experimental diets named F₁, F₂, F₃, F₄ and F₅ were formulated by incorporating various percentages of guar sprout meal at the rate 0, 25, 50, 75 and 100 respectively. The composition and proximate analysis of the experimental diets is described in Table 1. The fish were fed twice a day at (07:00 and 17:00 h) at the rate of 7% of their body weight per day during the first 30 days and 5% for the next 30 days. The average length and weights were recorded at 15-day intervals by randomly collecting 10 fish from each tank.

Analysis of proximate composition

The proximate composition of the various ingredients and the experimental diets was analyzed using standard protocols (AOAC, 1990). The proximate analysis of the carcass was carried out before the start of the trial (random 10 fish were sacrificed) and after the trial (5 random fish were collected from each tank) using the same protocols. Moisture, crude protein, crude lipid, and ash were determined for the whole fish.

Water quality

During the trial, daily siphoning was carried out with 50% of water exchange to maintain the optimum water quality parameters. The water quality parameters such as water temperature, dissolved oxygen and pH were monitored on a daily basis, while total alkalinity, ammonia, nitrite and nitrate were monitored on a weekly period. All the values were recorded in the morning between 0600 and 0700 h before exchanging the water by following the American Public Health Association protocols (APHA, 1998) and were found to be in the ranges of 27.1-28.85 °C, 4.7-5.5 mg/L, 7.6- 8.14, 81.95-92 mg/L,

0-0.1 mg/L, 0-0.2 mg/L and 0-4 mg/L respectively.

Fish growth and nutrient utilization

Growth and nutrient utilization were calculated as follows:

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

Weight gain% = [(Weight gain (g)) × (Initial weight (g)⁻¹)] × 100.

SGR = 100 × [ln (final weight (g)) - ln (initial weight (g))] × Days of experiment⁻¹.

Condition Factor (CF) = 100 × [Final body weight (g) × Total length⁻³ (cm)].

Feed conversion ratio (FCR) = Feed intake (g) × Wet biomass gains (g)⁻¹

Feed conversion efficiency (FCE) = Weight Gained × 100 × Feed Intake⁻¹

Protein efficiency ratio (PER) = Biomass gain (g) × Crude protein fed (g)⁻¹.

Biochemical constitution of blood

At the end of the experiment, the hematological study was carried out with a random sampling of 10 fish/tank and blood samples were withdrawn by caudal vein puncture with a fine needle and collected in heparin coated vials and centrifuge tubes (without anticoagulant). Serum were collected by centrifugation of the blood at 5000 rpm for 5 min at 4⁰C and thereafter stored at -20⁰C for further analysis. The blood samples were analyzed for hemoglobin measured using the methods described by Van and Zijlstra (1961) whereas the serum samples were analyzed for glucose, total protein, albumin, triglycerides and cholesterol. Total serum protein was measured using the methods described by Flack and Woollen (1984). While, serum albumin and globulin were analyzed by the method suggested by Dumas (1971). Serum glutamatic oxaloacetic transaminase (SGOT) and Serum glutamate pyruvate transaminase

(SGPT) activities were measured using Bergmeyer (1987). Total plasma cholesterol and triglycerides were measured using Agappe Diagnostics LTD kit (Agappe Hills, Pattimattom, Ernakulam, Kerala, India).

Statistical analysis

All the data were compared using one-way analysis of variance (ANOVA) and differences between means were tested for significance using Duncan's multiple range test. The significance level was set at $P < 0.05$ and the statistical analysis was performed with the software package SPSS Version 22.

Results and Discussion

Average body weight

The initial and final body weight of the experimental groups over the experimental period of 60 days has been recorded before and after the experiment (Table 2). The highest growth rate is observed with the diet F2 followed by diets F1 and F3, whereas the lowest growth is recorded with the experimental diet F4.

Weight gain and (%) weight gain

The details of total body weight gain and weight gain percentages are shown in Table 2. The F2 (25% sprout guar meal) experimental fish group shows significantly ($P < 0.05$) higher average individual weight gain and weight gain (%) followed by F1. Similarly, the lowest weight gain and weight gain (%) are observed with the F5 diet (inclusion level of GSM 100%).

Specific growth rate (SGR)

Specific growth rates (%/day) of experimental animals are given in Table 2. The maximum SGR has been recorded in F2 fed with 25%

sprout guar meal which is significantly ($P < 0.05$) higher among all the treatments followed by F1.

Feed conversion ratio (FCR)

The FCR values of the different experimental groups are presented in Table 2, which show significant differences among the treatments ($P < 0.05$). The one-way ANOVA shows that the lowest and the best FCR is observed in the F1 experimental diet followed by F2.

Feed efficiency ratio (FER)

The FER values show a significant difference among all the experimental groups ($P < 0.05$). While the treatments show a decreasing trend in FER from F1 to F5.

Protein efficiency ratio (PER)

There is a significant difference in PER observed among the treatments ($P < 0.05$). The significantly highest and lowest PER are recorded in F1 and F5 respectively. But there are no significant differences between F2 and F3.

Condition factor % (CF %)

There are no significant differences observed among all the treatments ($P > 0.05$).

Survivability

The survivability of Nile tilapia over the experimental period is shown in Table 2. The survival rate of experimental animals does not vary among the treatments ($P > 0.05$). The percentage survival is 100% in all the treatments.

Proximate composition of fish

The data of the proximate composition of the experimental animals in terms of moisture,

crude protein, ether extract and ash of carcass tissue before and after the experiment are shown in Table 3. The one-way ANOVA showed that there are no significant differences in the moisture content of carcass. The maximum protein content in the fish muscle is observed in F2 followed by F1 and F3 but there are no significant differences between F1, F2 and F3 experimental groups. The significantly highest and lowest crude lipid values are observed in F2 and F5 experimental groups respectively. Both experimental groups F1 and F2 does not show any significant difference but the highest mean ash level is recorded in F5.

Hematological parameters

The hematological parameters of experimental animals fed with different inclusion levels of sprout guar meal over a period of 60 days are given in Table 4.

There are significant differences observed in hemoglobin, albumin, cholesterol, triglycerides, total protein, SGOT, SGPT and alkaline phosphatase levels among the various treatment groups ($P < 0.05$) however no significant difference in globulin is observed among all the experimental groups ($P > 0.05$). Significantly higher hemoglobin is recorded in F1 followed by F2. Similarly, lowest hemoglobin recorded in F5. In the case of albumin, there are no significant differences between F1, F4 and F5. Almost similar levels of albumin are recorded in F2 and F3 experimental groups with no significant difference. An increasing trend of cholesterol levels is observed in the experimental groups F1 to F5 in a serial fashion. The highest triglyceride levels in serum is recorded in F2 followed by F1, F3 and F4 with a record lowest triglyceride level in F5. The lowest total protein content is perceived in F1 which is the control group while no significant differences are recorded in any of the treated

groups. However, a gradual increase of SGOT and SGPT in groups is observed F1 to F5. In the case of alkaline phosphatase level in serum, the significantly highest value is recorded in F5 followed by F4, F3, F1 and F2. Notably, there is a significant difference among the various treatments.

The global aquaculture industry is growing rapidly as a sunrise sector while most of the other food production sectors are showing either declining or stagnant trends. Planners and policy makers consider aquaculture as the most powerful tool for catering the global population under the emerging concepts of healthy food and blue economy. The global aquaculture market has been diversified over the time and the production is at present dominated by many omnivorous fish species including tilapia that live in both freshwater and brackish water. Feed has been an important component during the course of aquaculture development with enormous amounts of energy and financial resources invested towards formulating quality feed at an affordable price. Availability of commercial feeds plays a key role for promoting growth and health of the cultivable fishes which flags a potential opportunity for addressing the protein and nutritional security of the world. Fish meal is used as a prominent ingredient for making commercial tilapia feed due to its adequate palatability and exceptionally protein source contributing to a better growth and survival of the cultured animals.

In recent years, the feed manufacturing industry has been trying to reduce the usage of fish meal owing to the factors like high cost and reduced availability of the product coupled with concerns on sustainability from the scientific fraternity. Therefore, plant protein sources which are proved to be more ecofriendly can be the alternative sources for the substitution of fish meal (Cho and Bureau,

2002; Gatlin *et al.*, 2007; Alexander and Reinhard, 2011). Guar seed (especially its meal) is one of the potential nutrient sources for humans and land animals but very little attention has been given to use this resource in the aqua feed industry (Sayed *et al.*, 2016).

Interestingly, guar is a water resilient and versatile crop grows with limited inputs and can tolerate temperatures of 30°C to 40°C. Being a drought tolerant crop with a short cultivation period of 30-45 days in the summer months of April- July in India (ranging between 50-450 mm), and it serves as a potential alternative to fish protein source. Therefore, replacing fishmeal with guar meal has high ecological significance as far as the perspective of water conservation is concerned. Obviously, using guar meal in the

aqua feed industry will have long term repercussions in terms of water footprint and sustainability (Pahlow *et al.*, 2015).

In the present study, the proximate composition of carcass was analyzed prior to the start of the experiment and the final analysis was carried out at the end of the experiment. The crude protein level was decreasing from F4 to F5 (inclusion levels of 75 % and 100 % respectively). The crude lipid levels showed no significant difference in all the groups however, the lowest value was reported in F5 and the highest in F2. The higher level of protein and lipid deposition may support the animal in terms of better weight attainment and improved general health.

Table.1 Formulation of experimental diets fed to fingerlings of Tilapia (g/100 g)

Ingredients	Diet ¹				
	F ₁	F ₂	F ₃	F ₄	F ₅
Fishmeal	20.0	15.0	10.0	5.0	0.0
Soybean meal	22.0	22.0	22.0	22.0	22.0
Guar sprout meal	0.0	09.0	16.0	27.0	38.0
GNOC	10.0	10.0	10.0	10.0	10.0
Rice polish	21.0	18.0	17.0	15.0	12.0
Corn	22.5	21.5	20.5	16.5	13.5
Veg oil	02.0	02.0	02.0	02.0	02.0
Vit C ²	0.5	0.5	0.5	0.5	0.5
Vit + min ³	02.0	02.0	02.0	02.0	02.0
Proximate chemical composition %					
Moisture	2.99	2.91	2.48	2.46	2.68
Crude protein	29.31	29.23	28.96	28.88	28.79
Crude lipid	7.70	7.08	8.03	7.26	7.34
Ash	14.12	13.51	13.05	12.80	12.22

¹Percentage replacement of fish meal protein by sprout guar meal protein in the diets: (F1) 0%; (F2) 25%; (F3) 50%; (F4) 75%; (F5) 100%.

²Vitamin C: Ascorbic acid I.P., 100 mg; sodium ascorbate I.P., 450 mg; eq. ascorbic acid, 400 mg.

³Vitamin- Mineral Mixture: Vitamin (IU or g kg⁻¹premix): retinol palmitate, 50000 IU; thiamine, 5; riboflavin,5; niacin, 25; folic acid, 1; pyridoxine, 5; cyanocobalamin, 5; ascorbic acid, 10; cholecalciferol, 50000 IU; α -tocopherol, 2.5; menadione, 2; inositol, 25; pantothenic acid, 10; choline chloride, 100; biotin, 0.25.

Minerals (g kg⁻¹): CaCO₃, 336; KH₂PO₄, 502; MgSO₄.7H₂O, 162; NaCl, 49.8; Fe(II) gluconate, 10.9; MnSO₄.H₂O, 3.12; ZnSO₄.7H₂O, 4.67; CuSO₄.5H₂O, 0.62; KI, 0.16; CoCl₂.6H₂O, 0.08; ammonium molybdate, 0.06; NaSeO₃, 0.02.

Table.2 Final weight, percentage weight gain, feed conversion ratio, specific growth rate and percentage survival of Tilapia fingerlings fed with five practical diets. (P < 0.05)

	Diet						
	F ₁	F ₂	F ₃	F ₄	F ₅		
Initial body weight (g)	4.26±0.02 ^a	4.26±0.01 ^a	4.26±0.01 ^a	4.26±0.02 ^a	4.26±0.01 ^a	y = -7E-15x + 4.26	R ² = -17.3
Final body weight (g)	27.10±0.25 ^b	27.48±1.15 ^b	24.26±1.85 ^b	14.98±0.22 ^a	13.22±0.30 ^a	y = -0.7386x ² + 0.4054x + 28.316	R ² = 0.9136
Weight gain	22.94±0.61 ^b	23.32±1.19 ^b	20.02±1.86 ^b	10.72±0.23 ^a	8.96±0.31 ^a	y = -0.7343x ² + 0.3497x + 24.22	R ² = 0.914
Weight gain (%)	2293.97±61.14 ^b	2332.33±118.84 ^b	2002.30±185.80 ^b	1071.97±22.58 ^a	895.83±30.78 ^a	y = -73.521x ² + 35.465x + 2421.6	R ² = 0.914
FCR	0.94±0.02 ^a	1.13±0.05 ^{ab}	1.25±0.13 ^b	1.98±0.08 ^c	2.02±0.07 ^c	y = 0.0221x ² + 0.1681x + 0.716	R ² = 0.9062
FCE or FER	107.05±2.34 ^c	88.67±4.07 ^b	81.51±7.84 ^b	50.80±2.17 ^a	49.75±1.78 ^a	y = 0.7936x ² - 20.008x + 126.85	R ² = 0.9417
SGR	3.08±0.02 ^b	3.10±0.07 ^b	2.89±0.13 ^b	2.09±0.03 ^a	1.89±0.04 ^a	y = -0.0736x ² + 0.1024x + 3.112	R ² = 0.9223
PER	6.33±0.16 ^c	5.19±0.20 ^b	4.86±0.43 ^b	3.17±0.14 ^a	3.14±0.14 ^a	y = 0.0614x ² - 1.2086x + 7.488	R ² = 0.9396
CF (%)	1.71±0.15 ^a	1.74±0.03 ^a	1.78±0.02 ^a	1.80±0.04 ^a	1.89±0.03 ^a	y = 0.0071x ² - 0.0009x + 1.708	R ² = 0.9701
Survival (%)	100	100	100	100	100	-	-

^{a-c} Different superscripts indicate significant difference among treatments (P<0.05)

Table.3 Proximate composition of fish fed with different experimental Diet (% wet weight)

Parameter	Diet					
	Initial	F ₁	F ₂	F ₃	F ₄	F ₅
Moisture	79.42±0.31	76.88±0.16 ^a	76.70±0.44 ^a	76.93±0.07 ^a	77.19±0.26 ^a	77.31±0.28 ^a
Crude protein	11.34±0.07	14.13±0.10 ^b	14.20±0.16 ^b	13.79±0.16 ^b	13.03±0.06 ^a	12.86±0.14 ^a
Crude lipid	4.33±0.06	5.20±0.14 ^{bc}	5.38±0.11 ^c	5.04±0.11 ^b	4.97±0.07 ^b	4.64±0.06 ^a
Ash	3.98±0.13	2.82±0.09 ^a	2.76±0.03 ^a	3.27±0.15 ^b	3.83±0.04 ^c	4.20±0.13 ^d

Means in the same column followed by different superscripts differ significantly (P<0.05) F1, F2, F3, F4, and F5 are experimental diets with Guar sprout meal incorporated at 0, 25, 50, 75 and 100 % graded levels respectively

Table.4 Hematological characteristics of Tilapia fingerlings fed with five practical diets. (P < 0.05)

	BLOOD PARAMETERS				
	F ₁	F ₂	F ₃	F ₄	F ₅
Hemoglobin (g/dl)	6.20±0.01 ^d	6.70±0.004 ^e	5.90±0.02 ^c	5.10±0.01 ^b	5.01±0.01 ^a
Albumin (g/dl)	2.10±0.05 ^a	2.21±0.005 ^b	2.20±0.01 ^b	2.10±0.01 ^a	2.10±0.003 ^a
Globulin (g/dl)	1.01±0.003 ^a	1.01±0.01 ^a	1.01±0.01 ^a	1.01±0.004 ^a	1.01±0.01 ^a
Cholesterol (mg/l)	142.67±0.33 ^c	138.00±0.58 ^d	118.33±0.88 ^c	103.67±0.67 ^b	85.07±0.07 ^a
Triglycerides (mg/dl)	83.10±0.21 ^d	100.00±0.17 ^e	82.17±0.09 ^c	70.83±0.12 ^b	63.99±0.07 ^a
Total Protein (g/dl)	3.01±0.01 ^a	3.22±0.01 ^c	3.23±0.03 ^c	3.12±0.01 ^b	3.12±0.01 ^b
SGOT/AST (U/L)	59.00±0.003 ^a	190.00±1.15 ^b	195.01±0.01 ^c	197.99±0.01 ^d	200.00±0.01 ^e
SGPT/ALT (U/L)	49.73±0.37 ^a	97.67±0.33 ^b	123.00±0.58 ^c	130.90±0.15 ^d	134.96±0.04 ^e
Alkaline Phosphatase (U/L)	42±0.01 ^b	39.02±0.01 ^a	45.00±0.01 ^c	48.98±0.02 ^d	54.00±0.58 ^e

^{a-e} Different superscripts indicate significant difference among treatments (P<0.05)

The study reported a gradual increase in the ash values in treatments, F2 to F5. Moreover, several studies demonstrated that high inclusion level of plant protein sources in diets decreased the body lipid content of fish (Noble *et al.*, 1998; Wm Kissil *et al.*, 2000; Opstvedt *et al.*, 2003; Tibaldi *et al.*, 2006). However, some researcher found that the body lipid content of fish was reported to be increased or not affected by diets containing various levels of plant protein sources (Yang *et al.*, 2001; Kaushik *et al.*, 2004; Dias *et al.*, 2005; Zhou *et al.*, 2005).

A similar kind of experiment was conducted by Sayed *et al.*, (2016), investigating the effect of guar meal as a protein source replacing soybean meal in Nile tilapia fingerlings. The 105-day study showed excellent fish performance at all inclusion levels, but a decline in the growth rate was reported with an increase in the inclusion of GM levels beyond 20%. Simultaneously, the feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) was showing a decline with increasing dietary GM up to 20%. Furthermore, the PER was found to be lowering with increasing GSM levels beyond 50%. The study concluded that 100% inclusion of GM is possible with respect to SBM in terms of economic feasibility, which proves that the inclusion of 25% sprout guar meal showed better growth rate than the control (0% inclusion) and other graded levels of inclusion.

A comparative study was carried out by Njaiam *et al.*, (2014) where the guar meal was used as a substitute for soybean meal for the species, Asian catfish *Pangasianodon hypophthalmus*. The experimental (isonitrogenous and isolipidic) diets were formulated containing guar meal at 0, 5, 10, 15 and 20% by replacing soybean meal wherein the first diet was designated as the

control diet. The 45 –day rearing experiment showed that the proximate composition didn't show any significant difference in the replacement of the SBM with GM from 10% to 50%. Pach and Nagel (2016) observed that the guar meal when incorporated as an alternative for SBM in the nutrition of rainbow trout, significant protein reduction when SGM was replaced with GM above 10% (100 g. per kg feed) but no significant difference was observed in the condition factor, hepatosomatic index, slaughter yield and fillet yield. It was concluded that the guar meal can effectively replace SBM without any adverse effect to the species. The diet containing 100% GSM (F5) and 0% GSM (F1) showed the highest and lowest FCR values, respectively and no significant difference found in FCR values between the diets containing 0% GSM (F1) and 25% GSM (F2). Similarly, F2 (25% GSM) and F3 (50% GSM) did not show any significant difference in FCR values. Such an observation clearly indicates that inclusion of GSM could improve the feed quality and it can replace fish meal up to 50%.

Thobaiti *et al.*, (2017) discussed the effect of alternative plant protein sources as replacement for fish meal in Nile tilapia that showed a replacement of 20- 50% fishmeal diet did not have any impact on the growth and chemical composition of muscle. It may be noted that the current trial used sprout guar meal instead of guar meal with evident superior nutritional qualities in the former. Furthermore, it is a proven fact that the antinutritional factors present in guar meal are eliminated by sprouting, fermentation, autoclaving, boiling etc.

The present study clearly shows a drastic change in the hematological parameters in different treatment groups. The hemoglobin content was found to be gradually decreasing from F1 to F5 indicating that the presence of

animal protein in the diet increases the hemoglobin level compared to the plant protein. The cholesterol content also showed a similar pattern in the various treatments. In the case of triglycerides, F5 showed the highest value while F2 showed the lowest. The total protein content remained the same in treatments F2 & F3 and F4 & F5 (3.23 and 3.12 g/dl respectively). Such values might have helped to maintain the constant supply of protein throughout the period to ensure the growth performance in experimental animals. The SGOT/ AST and SGPT/ ALT values showed a gradual increase from F1 to F5. The lowest alkaline phosphatase value was recorded in F2 and the highest in F5. The overall hematological results throw light on the possible effect of guar sprout meal in fish protein supply levels. A similar study was conducted by Najim *et al.*, (2014) replacing fish meal protein by fish biosilage at the graded levels of 0, 25, 50 and 75% in the diets of common carp (*Cyprinus carpio*) fingerlings. After the 14- week experiment, it was concluded that fish silage could be a good replacement for fish meal without adverse effects on blood parameters (RBC, WBC, Hb and Hct). According to Solomon *et al.*, (2014) *Clarias gariepinus* fingerlings showed improvement in blood parameters (WBC, HGB, RBC, and PCV) in fish fed with Bitter Kola (*Garcinia kola*) seed meal compared to the control (without bitter kola seed meal).

In conclusion the replacement of fish meal with guar sprout meal is a feasible proposition in the tilapia feed industry to ensure the sustainability of the sector. This concept can bring promising and sustainable results on a long term basis under the light of fish meal shortage observed around the globe. Shifting to water resilient crops for meeting the protein requirement would be a great indication as the world is facing severe water crisis due to climate change and environmental

degradation. Further studies are required to enhance the level of inclusion of GSM by integrating some certain essential amino acids like lysine, methionine, taurine etc. in the diet while the FM replacement is tried.

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Conflict of interest

There is no conflict of interest involved in this manuscript.

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