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EVALUATION OF GROUNDNUT OIL CAKE AS A SUBSTITUTE OF FISHMEAL FOR *TILAPIA*

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ABSTRACT
The present deals with the influence of solvent extracted De oiled Groundnut oil cake (GOC) as a partial or total replacement of fishmeal on juvenile *Tilapia mossambica (*mean weight 3.22. ±0.2gm, n=15). Five iso nitrogenous and iso energetic diets containing different levels of De oiled Groundnut oil cake (GOC)meal (0, 5, 10, 15 and 20%) were prepared and were fed to triplicate group and growth responses and food utilization of fingerlings were noted. Initial and final mean weights, percentage weight gains (WG), and specific growth rate (SGR) was calculated.

Results indicated that mean average body weight on commercial fish meal was significantly different from all other trail diets except fish fed with test diet 3 (15%) where the body weight gain was significantly higher than test diet 4(20%). The mean body weight among the fishes fed with test diet- 1 (5%) and 2 (10%) were statistically not significant. Diet 5 (20%) showed the best SGR followed by diet 4, diet and diet 3 respectively. The SGR of diet 2 was lowest. The best result of total feed fed by fish was found in diet 5 (5.58) followed by diet 4 (5.57) and diet 3 respectively. The lowest amount of feed fed (5.13) was in diet 2. The weight gain and specific growth rate of the experimental fish fed were not much better than control group ($p<0.1$). The fish fed with 15% GOC diet shown more or less similar values like control fish hence GOC fish fed with 15% GOC is suggested for fish feed

KEYWORDS: Groundnut oil cake (GOC), Fishmeal, Specific growth rate (SGR), Tilapia

INTRODUCTION

The modern aquaculture industry has not only led to significant socio-economic benefits but also provided income, employment, foreign exchange and food security (Allison, 2011).The increase in the cost of raw ingredients for commercially manufactured aqua feeds caused in a significant rise in aqua feed prices from 20 to 40 percent, thus forcing farmers to adopt substitute tactics to secure nutritious feeds. Accordingly, growers are searching for alternative sources of feeds from plant seed/grain by-products. These types of involvements help to fight against mounting feedstuff costs without compromise of fish growth, health and welfare. However, it could reduce fish productivity and production (Rana *et al*, 2009, Ghosh and Ray, 2017). Oil cakes are rich in fiber, protein and energy contents. These oil cakes and meals are rich in protein and are frequently used as feeds for farm animal (Ramachandran *et al*, 2007). A big amount of several kinds of oilseed cakes, meals like soybean, cottonseed, sunflower meal, and groundnut are formed in India as by-products of the edible oil industry. Groundnut accounts around 25% of the total oilseed production of the India. Groundnut is a valuable source of vitamins E, K and B. It is the richest plant source of thiamine (B1) and rich in niacin, which is low in cereal FAO (2000).

The groundnut cake is rich in protein and in other nourishing values. However, it is deficient in important amino acids like lysine and methionine and contains fewer amounts of tryptophan and threonine (Davies and Ezenwa, 2010). Groundnut cake with crude protein content of 40- 45% is a good supplement as it is delicious and promotes fish growth. The groundnut cake (GOC) can replace 25% of fish meal in the diet of tilapia *Sarotherodon mossambicus* (Jackson *et al*, 1982). GOC is a fabulous source of arginine but deficient in lysine, cysteine and methionine. However, it also includes many anti-nutritional factors (ANFs) like trypsin inhibitor, tannin and phytic acid which lowers the value of protein (Nyina-Wamwiza *et al*., 2010).

The efficacy of the various alternative protein sources as partial or complete dietary replacement for fishmeal has been evaluated many workers. (Sharma *et al.*, 1978; Ramachandran *et al.*, 2007; Ananth *et al.*, 2016; Nayak *et al.*, 2017; Nayak *et al*, 2018; Bhilave, 2018; Ranjan *et al.*, 2018). For that reason, the present study is aimed to evaluate the effects of combination of soybean meal (SBM) as alternative for dietary fish meal (FM) protein for fingerlings of *Tilapia.*

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MATERIALS AND METHODS

Fish: The fingerlings of *Tilapia mossambicus* with an average initial weight of 3.2g were collected from the local fish hatchery and were used for experiments. After acclimatization 150 fish were then randomly divided into 5 different groups with 3 replicates. Fingerlings were fed with commercial diet at a daily rate of 10% of their body weight till 48 h before the start of the experiment. The experimental fish were fed twice daily at morning and evening at a fixed feeding rate of 5% of the total biomass for a period of 45 days. No mortality of fingerlings was noticed.

Formulation of seed oil cake for fishmeal*:* De oiled Groundnut oil cake (GOC) was purchased from 'Star Multi Nationals Exports and Imports, Omalur Taluka, Salem, Tamilnadu, India. Other feed ingredients were obtained from 'BIO GENETICS, Hyderabad, Telangana (India).

Preparation of feed: Groundnut oil cake (GOC) was dried at 80 °C in hot air oven, (to inactivate ANFs), beached, and passed through a fine mesh sieve (400 µm in diameter) to ensure homogeneity and the powder was used for preparation of meal. The ingredients were thinly powdered and strained to obtain uniform particle size (<400 µm) and mixed thoroughly in proportion mentioned in Table1. A vitamin mineral premix was procured from Bio Genetics Ltd, Hyderabad, Telangana (India). Cod liver oil was added (1% each) to the diets before making the pellets. The mixture was made to breads using lukewarm water and 0.5% agar agar as binder. The bread was passed through an electrically operated semi-automatic pelletizer. The pellets of 1.5 mm were obtained and sun dried for 6 h initially and further in a hot air oven at 60 °C for 96 h. The dried pellets were squeezed and packed in airtight plastic bags and preserved in a refrigerator. The raw GOC was dried and analyzed for proximate composition.

Four sets of iso nitrogenous and iso caloric experimental diets were prepared by incorporating raw GOC at 5%,10%,15% and 20% levels by weight replacing fish meal (FM). The feeding experiment was performed under normal laboratory conditions for 45 days with continuous aeration. A diet with commercial fishmeal (FM) as the main protein source and without GOC was used as the control (control).The fingerlings (mean individual weight of the 500 fingerlings 4.54 ± 0.11 g) were randomly distributed in the glass aquaria at a stocking density of 15 fish per aquarium with three replicates for each experimental diet. Five iso nitrogenous and iso energetic diets containing different levels of groundnut oil cake (GOC) (0, 5, 10, 15 and 20%) were prepared using a pellet press with 2 mm diet while control diet was devoid of GOC meal. Dry pellets were mixed with Summet mixer in laboratory for 30 minutes. The fish oil was slowly included while mixing constantly and 85 ml of water per 100g of feed was slowly blended into mixer. Drying was carried out in conventional oven at 35^{o}C for 48 hours. The dry product was cut into pellets of 2 mm size. The fish were fed twice daily at 7.00am and 5.00pm at a feeding rate of 5% (w/w) of the total body weight per day (Saha and Ghosh, 2013; Roy *et al.*, 2014). Daily feed intake and weekly weight gains were recorded.

Table.1. Percentage composition in different diets on dry matter basis (DMB)

Ingredients g/ kg-1	Groups				
	A	B	C	D	E
Fish meal	70	65	60	55	50
Rice powder	06	06	06	06	06
Wheat meal	14	14	14	14	14
Fish oil	4.5	4.5	4.5	4.5	4.5
Vitamin mix1	2	2	2	2	2
Mineral mix2	2	2	2	2	2
Choline chloride	0.5	0.5	0.5	0.5	0.5
Vitamin C	1	1	1	1	1
Groundnut Oil Cake(GOC)	---	05	10	15	20
Total%	100	100	100	100	100

The rejected feed was immediately drained out, dried and weighed. It helped us to calculate the exact amount of feed intake. The uneaten feed was siphoned off after 6 h of each feeding, and oven dried at 100 °C for 24 h to calculate the feed conversion ratio. Water restoration was done frequently before each feeding to remove uneaten feeds and to

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prevent contamination. About 80- 90% of the aquarium water was always replaced every morning. The survival of fingerling was also recorded everyday by counting and recording the mortalities. At the end of the experimental period all fish were taken out from the aquarium and body weight and length were recorded. The fish were starved for 24 h before recording their weights. In addition, the aquaria were siphoned daily to remove faecal materials. Fish in each tank were weighed individually and the average weight gain per aquarium was calculated. Air supply was clogged to prevent the crash of food pellets and leakage of nutrients from feed and faeces. Faeces were gently siphoned from the tanks on to a bolting silk cloth after 3 h of feeding from 2nd week of experiment and lasted for 15 days until enough samples were collected for chemical analysis. The feeding trial was conducted for 45 days.

1. Vitamin Mix: Vit.A, 18000 IU; Vit.D3, 2500, IU; Vit.E, 250 mg/kg; Vit.K3, 12 mg/kg; Vit.B1, 24 mg; Vit.B2, 50 mg; Vit.B3, 270 mg; Vit.B6, 20 mg; Vit.B12, 0.06 mg; Vit. C, 199 mg; Folic acid, 8 mg; Calcium d–pantothenate, 49 mg; Biotin, 1 mg; Inositol, 120 mg; Choline chloride, 1900 mg.

2.Mineral Mix: Fe, 76 mg; Cu, 13 mg; Mn, 204 mg; Zn, 84 mg; I, 2 mg; Se, 0.30 mg; Co, 1.5 mg.

Measurement of growth and weight*:* Growth performance of *Tilapia mossambica* fed with different formulated diets was considered by calculating weight gain (WG), specific growth rate (SGR) and feed conversion rate (FCR) at weekly interval, i.e. on 7th, 15th, 30 th and 45 th day of the experiment.

$$WG\ (\%) = [(\text{final weight (g)} - \text{initial weight (g)}) / \text{initial weight (g)}] \times 100$$
$$SGR\ (\%\ \text{day}^{-1}) = [(\text{final weight (g)} - \text{initial weight (g)}) / \text{days}] \times 100$$
$$FCR = \text{feed intake (g)} / \text{weight gain (g)}$$

10 fingerlings were randomly and carefully taken out from each aquarium and weighed. The total length was measured individually using a transparent ruler. Each day food quota was adjusted according to weight. The fingerling was put on a filter paper and the length of the head to the end of the tail was marked on the paper. Prior to weighing, fish were put on a filter paper to absorb the water on the body in aluminum foil. Electronic digital balance model K-Roy (Model, 10 Dx.K-16 Delux± 0.1g accuracy) was used for weighing.

RESULTS

The growth responses and food utilization of fingerlings (*Tilapia mossambica*) under different dietetic trails are presented in Table 2&3 and figure 1 and 2.The results clearly showed that, there was no significant differences ($p<0.05$) among all experimental fish in initial weight which reflect uniformity in fish weight at the starting of the experiment. The amount of approval of each experimental diet was judged by an individual feeding behaviour of the fish. The fingerlings eagerly consumed the feed and the level of appropriateness of all diets was more or less equal. No mortality of fingerlings was noticed and they were found more or less healthy throughout the study period.

Body weight gain% and specific growth rate (SGR) values in *Tilapia mossambica* fingerlings fed on reference and test diets are given in Table.2&3 and Fig.1,2 &3. Results revealed that the average final weight, weight gain and specific growth rate (SGR) did not differ significantly (P0. <05) of SGRs among the diets. Diet 4 (15%) showed the best SGR followed by diet 5 and diet 3 respectively. The SGR of diet 2 was lowest. But the SGR values of different diets did not differ significantly. We noticed significant ($P < 0.05$) differences in body weight gain of fish fed different levels of GOC. The weight gain and specific growth rate of the experimental fish fed with various concentrations of De oiled Groundnut oil cake (GOC) meal based diets were not much better than control group ($p<0.1$). The control fish fed with commercial diet registered highest weight gain (32.4%) and the least (24.1%) was Diet with 10% GOC. The inclusion of 5% GOC in fish meal reduced the growth and body weight of the finger lings significantly as compared to the control diet ($P<0.01$). The decrease in growth performance was linearly correlated with dietary meal level. However, no significant differences in specific growth rate and body condition were noticed in the fish fed with 10% and 15% of experimental diet. The efficiency of feed utilization slightly decreased linearly when the level of GOC in the diets increased over 5% compared to control. However, no significant ($P < 0.05$) differences were noticed in the feed conversion ratio (FCR) of diets containing either 10 or 15% or 20% of GOC meal. At the termination of the experiment, the control fish (fed with commercial diet) exhibited maximum values ($p < 0.05$) of final body weight (FBW), body weight gain percentage (BWG) and specific growth rate (SGR). While the experimental fishes fed with GOC showed the lower values.

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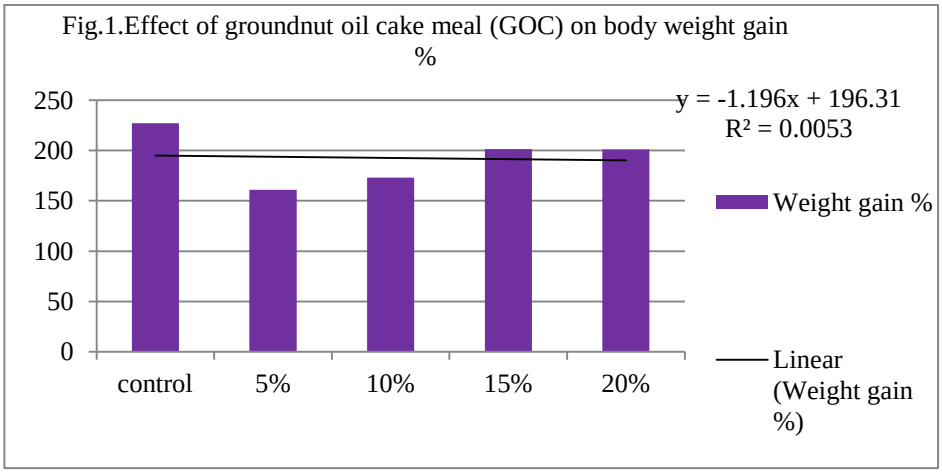
Table.2. Growth performance parameters of fingerlings of Tilapia mossambica fed with De oiled Groundnut cake meal (GOC) diets for 45 days

Experimental group	Initial weight (g)	Final weight (g)	Weight gain %	Specific growth rate (SGR)
control	3.17±0.30	10.37±2.11	227.1	16.0
5%	3.19±0.24	8.33±1.01	161.12	11.42
10%	3.22±0.21	8.79±1.12	172.98	12.37
15%	3.24±0.31	9.77±1.11	201.5	12.95
20%	3.20±0.40	9.63±2.04	200.93	14.28

Data are mean values of three replicates. Values are mean ± SEM. Means within a row having different superscripts were significantly different (P<0.05).



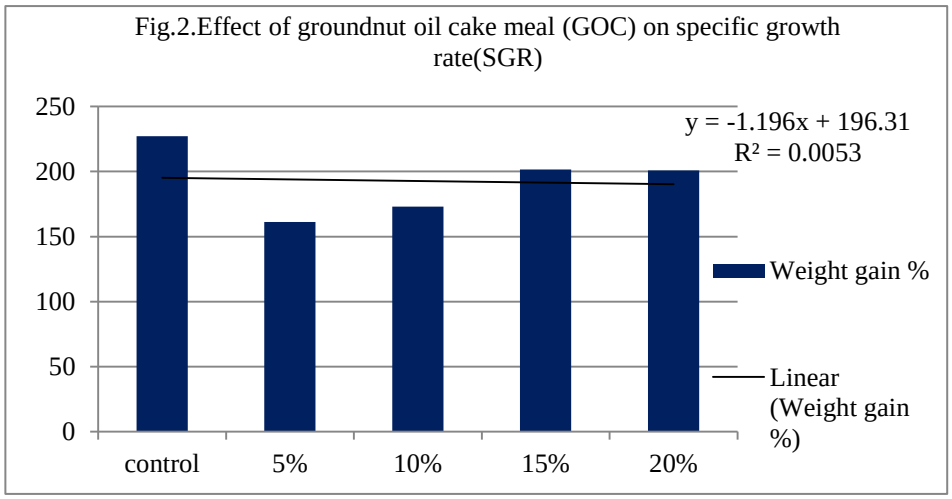


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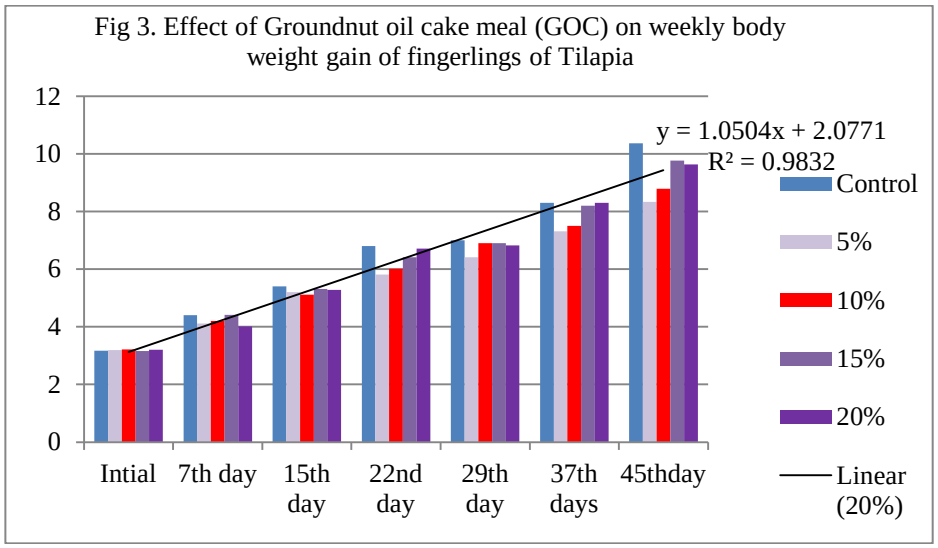
Table 3. Effect of Groundnut oil cake meal (GOC) on weekly body weight gain of fingerlings of Tilapia

Weight on the day	Control%	5%	10%	15%	20%
0 day (Initial)	3.17±0.30	3.19±0.23	3.22±0.21	3.16±0.2	3.20±0.40
7th day	4.40±0.31	4.12±0.19	4.2±0.22	4.42±0.13	4.01±0.31
15th day	5.4±0.28	5.20±0.27	5.12±0.30	5.31±0.17	5.28±0.21
22nd day	6.8±0.43	5.81±0.32	6.02±0.32	6.41±0.31	6.71±0.44
29th day	7.0±0.27	6.41±0.41	6.9±0.33	6.9±0.41	6.82±0.41
37th day	8.3±0.19	7.31±0.23	7.5±0.38	8.2±0.28	8.3±0.29
45th day	10.37±1.11	8.33±1.01	8.79±1.12	9.77±1.11	9.63±2.04



DISCUSSION

Groundnut accounts around 25% of the total oilseed production of the India. Available literature reveals that groundnut cake (GOC) with crude protein content of 40- 45% is palatable and promotes growth. GOC is an important source of vitamins E, K and B, thiamine (B1) and niacin (FAO, 2000). Hence, it can be used as a replacement for commercial fishmeal (Ramachandran *et al.*, 2007). However, GOC is known to be deficient in lysine and methionine and has poor quantity of tryptophan and threonine. (Pandey *et al.*, 2012). Statistical analysis revealed that effect of De oiled Groundnut cake meal (GOC) diets on percentage of body weight gain, and specific growth rate (SGR) were significant (P>0.05). Results indicated that mean average body weight on commercial fish meal was significantly different from all other trail diets except fish fed with test diet 3 (15%) where the body weight gain was significantly higher than test diet 4(20%). The mean body weight among the fishes fed with test diet 1 (5%) and 2 (10%) were statistically not significant. Regression lines (Fig. 1 and 2) showed trend in body weight gain and increase in SGR by fingerlings of *Tilapia* under the influence of four diets throughout experimental period was linear (y = -1.196x + 196.3, R^2 = 0.005). Even though the growth trend was different among different experimental groups, the overall increase was found to be linear. Among the four different diets tested, diet 3 (15%) showed higher growth as compared to other diets T1 (5%), T2 (10%) and T3 (20%).

The performance of fish in terms of average live weight gain (%) and specific growth rate (SGR, % day- 1) increased significantly (P<0.5) up to 15% incorporation (diet 3) and thereafter a decreased trend was observed. Even though the growth trend was different among different experimental groups, the overall increase was found to be linear. The better

mean body weight and specific growth rate in fish fed with commercial meal (control) might be due to presence of higher crude protein contents. Among the four different diets tested, diet 3 (15%) showed higher growth as compared to other diets T1 (5%), T2 (10%) and T3 (20%). Although, average final weight of the fish increased considerably from the initial value in all the dietary treatments, the results clearly established that inclusion of the De oiled Groundnut cake meal (GOC) oil cake in diets improved overall growth performance and nutrient utilization in *Tilapia* fingerlings. The performance of fish in terms of average live weight gain (%) and specific growth rate (SGR, % day- 1) increased significantly ($P<0.5$) up to 15% incorporation (diet 3) and thereafter decreased trend was observed. The 40-45% of protein content in GOC was sufficient for the growth and survival of Tilapia fingerlings. Deficiency of lysine and methionine in Diet 2 affected the growth performance of the fingerlings.

In comparison to the commercial reference diet, the present study observed an option of replacing 45–55% of commercial fishmeal through incorporation of 15% processed GOC in the diets for *Tilapia* fingerlings. The results of this experiment clearly indicated that GOC might be included up to 40% level (w/w) in the diet for *Tilapia* fingerlings. Our results are in agreement with that of Agbo *et al.* (2011); Desai *et al.* (2011) and Ghosh *et al.*, (2015).

CONCLUSIONS

Though GOC is said to be highly palatable and has good binding properties for pelleting (Lovell, 1989) there are some barriers in using GOC as fish feed ingredient. Even though it is an excellent source of arginine, but is deficient in lysine, cystine and methionine (Green *et al.*, 1988). Furthermore, GOC has been reported to contain major anti nutritional factors (ANFs), like tannin, trypsin inhibitor and phytic acid (Nyina-Wamwiza *et al.*, 2010). The tannins interfere and inhibit protease activity to form indigestible complexes with dietary protein which may reduce the growth in fish (Krogdahl, 1989, Hossain and Jauncey, 1989; Bairagi *et al*., 2002; Bairagi *et al*., 2004; Maitra and Ray, 2003; Mandal and Ghosh, 2013). Phytic acid has been reported to act as a chelator, to reduce protein and mineral bioavailability (Hossain and Jauncey, 1989). Therefore, removal or deactivation of the ANFs is essential before its effective utilization as a protein source in animal feed formulation (Jackson *et al.*, 1982).

The present experiment has demonstrated the suitable nutritional value of the processed GOC as an ingredient in fish diet. An inclusion level of up to 40% (w/w) processed GOC in the diet for *Tilapia* fingerlings shown in the present report had no undesirable effect on growth or body composition in comparison to the reference diet. Furthermore, inclusion of processed GOC (replacing 45% of reference diet) would be cost effective. However, it is too early to recommend to the commercial fish culture as it demands further testing in the field condition with large number of fish and replicates.

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