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Effect of Replacement of Fish Meal by *Roasted Guar Korma* on Growth Performance of *Puntius ticto*

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ABSTRACT

A ninety days feeding trial was conducted to evaluate the use of a roasted guar korma as an alternative protein source to replacement the expensive fish meal in diets for ticto barb (*Puntius ticto*). The five isonitrogenous experimental diets consisted of a control diet (100% fish meal) and four treatment diets in which fish meal replaced with roasted guar korma (25%, 50%, 75% and 100% of dietary protein) were prepared. The diets were formulated to provide 40% crude protein on a dry weight basis. Total 225 numbers of ticto barb (*P. ticto*) advanced fry were randomly distributed into five treatments (control + treatment), each in three replicate. They were fed *ad libitum* during the experimental duration. The daily ration was divided into three equal parts and was fed at 08:00 hr, 14:00 hr and 20:00 hr. Based on the results recorded from the present experiment, it was found that higher growth, SGR, PER, survival and lowest FCR were obtained by feeding the fish with the diet (T1) containing 25% roasted guar korma. Proximate composition of carcass shown negative effect on crude protein and crude lipid decrease with more than 25% of roasted guar korma based diet. Thus, it was revealed that the roasted guar kormareplacing 25% of fish meal in the diet of *P. ticto* advance fry gave better growth. Further research on used different plant based protein source with addition of essential amino acid, attractant and pigment effect on growth performance of fish.

Key words: *Roasted guar korma, Fishmeal replacement, Ticto barb, Puntius ticto*

Introduction

Aquaculture has been playing an important role in the economic development front on account of its contribution to food and nutritional security, national income, employment opportunities as well as generating livelihood options (Kumar and Shivani, 2014). Ornamental fishes form an important commercial component of aquaculture (Swain *et al.*, 2008) and many similarities to food fish aquaculture (Tlusty, 2002). India contributes very negligible 1.6 million USD$ in international ornamental fish trade with 31st rank in word ornamental production sector. India has been exporting some unique varieties of wild caught ornamental fish to many developed counties of the world since 1969 (Jain *et al.*, 2016). Basu *et al*. (2012) found that *Puntius ticto* indigenous ornamental fish of Indian subcontinent. The people of North East India are consume fermented product shidal (Thapa *et al*., 2006; Muzaddadi, 2015), godak (Dhar *et al*., 2012), naming (Devi *et al*., 2015) prepared from Puntius spp.. Fermented foods also acquire a distinctive taste, enhance digestibility, add palatability and improve nutritional and medicinal values (Dhar *et al*., 2012). Nutrition has a significant role in maintaining excellent health and normal behaviour, boosting the outward appearance and reproductive performance of ornamental fish. How-

ever, nutritional statistics of ornamental fish are mostly dependent on the extrapolation of results acquired from diet fish in intensive farming techniques (Keshavanath and Patil, 2006). Fish meal is regarded to be the best component among regularly used feed components since it is compatible with the protein requirements of fish (Alam *et al.*, 1996). Ornamental fish farmer have knowledge about nutritional requirement, feeding behaviour and feeding habit of different species in order to formulate farm made feeds using locally available cost effective quality ingredients (Jain *et al.*, 2016). Plant based feed formulated and used in aquaculture (Tacon *et al*., 2009). There is no adverse effect on growth performances of fish and feed production cost was reduced with the use of plant protein source (Zhang *et al*., 2012; Yun *et al*., 2014). Due to rising the cost and uncertain availability of fishmeal is necessary to replace with cheaper ingredients of plant origin in fish feed (Higgs *et al*., 1995). Guar is primarily grown as an industrial crop, but it is also used as forage for cattle, thanks to its high protein content Guar (*Cyamopsis tetragonoloba*) (Whistler and Hymowitz, 1979). According to Ramteke *et al*. (2014), Roasted guar (*Cyamopsis tetragonoloba*) korma is a by-product of the guar gum industries that is left over after the gum has been removed. The protein content of the roasted guar korma was 50.27% (Tyagi *et al*., 2011), which is less costly than other protein source. Plant based nutrient content anti nutritional factor (Hajra *et al*., 2013). Its antinutritional properties can be lessened by heating it and adding enzymes (Hussain *et al*., 2012).

However, no work has been performed on the replacement of fish meal with roasted guar korma (RGK) to evaluate the growth performance of *P. ticto*. Keeping this in mind, the presentwork was planned to prepare an advance fry diet, high percentage of fish meal replacement by a mixture of plantprotein sources affects growth, survival performance, carcass composition of *P. ticto*.

Materials and Methods

Seed collection

The seed were collected from Ukai dam canal (21°15′03.45" N 73°33′35.45" E). The fish seed was collected by using fine-meshed dragnet. The net was used in shallow water body where flow is gentle. Seed collection gear was operated by four men to cover maximum area. Plastic bucket was half filled with creek water. All the fish species were transferred into plastic bucket. The collected fish seeds were brought to wet lab. To avoid stressful condition provided aeration for freshly collected seed. Fish species were segregated with a scoop net. Fish seeds were acclimatized with clean and aerated water.

Experimental design and fish

An experimental design was completely randomized design followed. Advance fry of *Puntius ticto* were randomly selected and distributed in five distinct experimental groups in triplicate. The experimental setup consisted of 15 plastic tanks (50 L capacity). The tanks were washed with potassium permanganate solution (4 mgl^{-1}) thoroughly and cleaned with fresh water. Each tank was covered with a lid to prevent fish from jumping out. Each plastic tank containing 50 L dechlorinated water was stocked with 15 fishes. Bore-well water source (ground water source) during entire experimental period. Two hundred twenty five (225) fishes were randomly distributed in five distinct experimental groups. Advance fry of *Puntius ticto* (Ticto barb) with total average length of 1.39 ± 0.003 cm (mean ± SE) and weighing 0.74 ± 0.004 g (mean ± SE) were selected for the experiment. The fishes were fed with a control diet for 15 days before the commencement of experiment. The experimental tanks were cleaned manually and siphoning was done every day after fish fed up to *adlibitum*. For remove excess feed pellets and the remaining fecal matter regular siphoning needed. An equal volume of clean water replaced the siphoned water. This was carried out throughout the experimental period of 90 days. No extra facility provided were made to stimulate or control the environmental condition. The experimental condition was kept same throughout the experiment. The weight was measured at interval of 15 days (fortnight) to assess the growth. The fishes were starved overnight (24 hrs.) before taking body weight. The natural and artificial light cycle was 12 h natural light/12 h artificial light (24 h light) for the experiment.

Continuous aeration was supplied by using small aeration pump to maintain the dissolvedoxygen (DO). Aeration helps inremoving ammonia from the tank water. The waterquality parameters like temperature, pH, DO, ammonia, nitrite, nitrate, hardness, alkalinity in the experimental tanks was esti-

mated with Thermo scientific instrument and Hanna multi water parameter testing kit.

Feed formulation, feeding and carcass composition

Five isonitrogenous experimental diets were prepared with 40% protein level *viz.* T0 = control (100% fish meal as primary protein source; 0% roasted guar korma), T1 = (75% of fish meal and 25% roasted guar korma), T2 = (50% of fish meal and 50% roasted guar korma), T3 = (25% of fish meal and 75% roasted guar korma) and T4 = (0% of fish meal and 100% roasted guar korma). Ingredients such as fish meal, roasted guar korma, wheat bran, rice bran, fish oil (Seacod liver oil), multi vitamin and mineral tablet were used for feed formulation. Proximate composition of ingredients used for preparation of treatment diets is shown in Table 1. Ingredients and formulation of the experimental diet shows in Table 2. Formulation of experimental diet process follow as directed in Pillay and Kutty (2005). The ingredients in the relevant formula were finely ground and passed through a sieve of nylon mesh. Weighed ingredients were mixed thoroughly, oil was added and then they were mixed again for a few minutes. The starch gelatinized with water, is added to the mixture and mixed well to form a dough. Then dough was steamed with pressure cooker. Added vitamin and mineral capsule and mix thoroughly. Feed extruded with stainless steel noodle maker and feed dried with sun drying method. Proximate composition of feed ingredients and fish carcass were determined by the standard methods (AOAC, 2005). Feeding was done at the rate of 5% of body weight initially and after 10 days it was fed up to fish were apparent satiated till the end of experiment (Catarino *et al*., 2019). The feed was manually supplied into three equal parts of daily ration and was given at 08:00, 14:00, and 20:00 hrs.

Growth parameter

Growth of the experimental fish was measured at every 15 days intervals by mass weighing ofall the individuals in the tanks. The fish were keptstarved overnight before weight measurement. Various growth parameters and nutrient utilization of experimental fish were evaluated as follows Lin *et al.* (2015).

$$\text{Average body weight gain} = \frac{\text{Final body weight} - \text{Initial body weight}}{\text{Initial body weight}}$$

$$\text{SGR} = \frac{\text{Log}_e \text{ Final weight} - \text{Log}_e \text{ Initial weight}}{\text{Number of experiment days}} \times 100$$

$$\text{FCR} = \frac{\text{Amount of feed intake(g)}}{\text{Wet weight gain (g)}}$$

Table 1. Proximate composition ingredients used for formulation of treatment diets

Ingredients	Moisture	Dry matter	Ash	Protein	Fat
Fish meal	5.50	94.50	24.53	54.00	5.56
Roasted guar korma	6.89	93.11	10.6	53.00	5.21
Rice bran	11.87	88.13	8.67	12.00	1.03
Wheat bran	9.96	90.04	4.56	12.00	2.84
Tapioca Flour	6.88	93.22	0.56	0.41	0.15

Table 2. Ingredients and formulation of the experimental diet (g100 g diet^{-1})

Ingredients	Diets				
	T0(Control)	T1(25%)	T2(50%)	T3(75%)	T4(100%)
Roasted guar korma (53 CP)	0.00	17.75	35.5	53.25	71
Fish meal(54 CP)	71	53.25	35.5	17.75	0.00
Wheat bran(12 CP)	1.00	1.00	1.00	1.00	1.00
Tapioca	2.00	2.00	2.00	2.00	2.00
Rice bran(12 CP)	19.00	19.00	19.00	19.00	19.00
Sunflower oil	3.00	3.00	3.00	3.00	3.00
Fish oil	3.00	3.00	3.00	3.00	3.00
Vitamin mixture	1.00	1.00	1.00	1.00	1.00
	100	100	100	100	100

$$\text{FER} = \frac{\text{Increment in body weight (g)}}{\text{Feed intake (g)}}$$

$$\text{FER} = \frac{\text{Increment in body weight (g)}}{\text{Protein intake (g)}}$$

$$\text{Survival (\%)} = \frac{\text{No. of fish survived after rearing}}{\text{No. of fish stocked}} \times 100$$

Statistical analysis

Statistical analysis of different growth and physiological parameters were analyzed by one-way analysis of variance (ANOVA) using SPSS VERSION 25.0. Duncan's multiple range tests was used for post hoc comparison of mean ($P < 0.05$) between different groups. All the data presented in the text, figures and tables expressed are mean ± standard error and statistical significance of the test was set at $P < 0.05$.

Results

Water quality

The values in range for water quality parameters like temperature, pH, DO, ammonia, nitrite nitrate, alkalinity and hardness were recorded as 20.5 to 26.8 °C, 7.9 - 8.2, 6.79 to 6.90 ppm, 0.064 to 0.075 ppm, 0.13 to 0.15 ppm, 1.74 to 1.95 ppm, 141.76 to 158.76 ppm, 143.59 to 153.23 ppm, respectively were found to be within the desired range. Fortnight temperature was shown in graphical form in Fig. 8.

Growth parameter

Growth parameter and survival rate calculated with formula result shown in Table 3. Average body weight gain (ABWG), Fortnight average weight gain, % SGR, feed conversion ratio (FCR), feed efficiency ratio (FER), protein efficiency ratio (PER) and survival rate (%) were presented in graphical form Fig. 1, 2, 3, 4, 5, 6, 7, respectively. The highest average body weight gain (1.93 ± 0.02) and % SGR (0.452 ± 0.001), FER (0.0263 ± 0.0003), PER (0.0653 ± 0.001) were observed in the T1 treatment, which were significantly different ($P < 0.05$) with other treatments. Onthe otherhand, the lowest SGR and BWG values were recorded in the T4 treatment fed with only a roasted guar korma. The highest FCR value was recorded in the T4 (2.90 ± 0.05) followed by T3 (2.87 ± 0.07) treatment. No significant ($P > 0.05$) differences for FCR values were found between T3 and T4 treatments but significantly different ($P < 0.05$) with T0, T1 and T2 treatments. The highest FER was found in T1 diets (0.0263 ± 0.0003). The lowest FER was observed in T4 diet (0.0237 ± 0.0003) treatment fed with only RGK with respect to FER, all the treatments differed with each other significantly ($P < 0.05$). The highest PER was found in T1 diets (0.0653 ± 0.001). The lowest PER was observed in T4 diet (0.0617 ± 0.001) treatment. With respect to T1 treatment was higher than control but there is no significance different ($P > 0.05$) found between them. The lowest survival rate (95.6%) was found in the T3 treatment, whereas the highest survival rate (100%) was observed in T1 and T2 treatments, which was not significantly difference ($P > 0.05$) among the all treatments.

Carcass composition

At the beginning and at the end of the feeding period, a random sample of five fish from each tank were collected and dried for subsequent chemical analyses. The data for proximate analysis of fish whole body before and after the experiment is given in Table 4. The proximate compositions of each species were analysed by standard 'AOAC' procedures

Table 3. Growth parameter and survival rate of different treatments at the end of experiment.

	Treatments				
Parameters	T0 (C)	T1	T2	T3	T4
Average body weight gain	0.94 ± 0.03^{b}	1.17 ± 0.01^{a}	0.82 ± 0.03^{c}	0.66 ± 0.01^{d}	0.26 ± 0.01^{e}
Specific growth rate (%)	0.392 ± 0.005^{b}	0.452 ± 0.001^{a}	0.354 ± 0.006^{c}	0.305 ± 0.001^{d}	0.144 ± 0.007^{e}
Feed conversion ratio	2.67 ± 0.03^{b}	2.57 ± 0.03^{b}	2.67 ± 0.04^{b}	2.87 ± 0.07^{a}	2.90 ± 0.05^{a}
Feed efficiency ratio	0.0257 ± 0.0007^{ab}	0.0263 ± 0.0003^{a}	0.0250 ± 0.00^{abc}	0.0247 ± 0.0007^{bc}	0.0237 ± 0.0003^{c}
Protein efficiency ratio	0.0647 ± 0.002^{a}	0.0653 ± 0.001^{a}	0.0623 ± 0.001^{ab}	0.0617 ± 0.001^{ab}	0.0587 ± 0.001^{c}
Survival rate (%)	97.8 ± 2.2^{a}	100.00 ± 0.00^{a}	100.00 ± 0.00^{a}	95.6 ± 4.44^{a}	97.8 ± 2.2^{a}

Means identified by different superscripts (a, b and c) in the row were significantly different ($P<0.05$) for each parameter analysed.Values are mean ± SE (n=3).

(AOAC, 2005).

The moisture content in the fish body at the beginning of experiment was 76.83 ± 0.27%. At the end of the experiment, it was found no significance difference between T2, T3 and T4 treatment but significance difference ($p < 0.05$) found between T0 and T1, also with other treatments. The range of moisture content was found 75.97 ± 0.08 to 76.67 ± 0.04 %. The crude protein of whole body before experiment was found 14.32 ± 0.24. After the experiment showed some variation and substitute of 25% of fish meal with roasted guar korma gave 16.67 ± 0.12% of protein in fish carcass. However, the variation has significant ($p < 0.05$) amongst the treatment except T3 and T4 treatments. The ether extract content at the beginning of experiment was 3.55 ± 0.15%. At the end of the experiment it was found in the range of 3.59 ± 0.03 to 3.63 ± 0.09%. Present study concluded that ether extract value was no significance difference ($p > 0.05$) found among the treatments but slightly decreasing with higher rate of roasted guar korma contain diet. The ash content at the beginning of experiment was 3.94 ± 0.12 while at the end of experiment it was found significance difference ($p < 0.05$) in the range of 3.68 ± 0.05 to 3.93 ± 0.05%.

Discussion

This is the first ever study over such a long duration undercontrolled conditions, to rear advance fry with replacement of fish meal by RGK. To evaluate growth performance and carcass composition of *P. ticto,* making comparisons with earlier studies of less research and shorter duration rather difficult. Experiment conducted during Sep to Dec for 90 days.

Average wet weight gain of fishes fed with treatment T1 found highest among all other treatments. With the increase level of RGK in diet showed decrease in average weight gain significantly difference all among treatments ($P < 0.05$). Patel and Mc Ginnis (1985) reported that increasing guar meal level in diet decreased BWG. Present study indicate that temperature effect the body weight gain. Brahman and Chandra (2014) similar result found with *Puntius ticto* fingerling experiment with formulated diets. The Specific Growth Rate in this result was better in T1 treatment which was 0.452 ± 0.001 and it is significantly differ from other treatments and as compare to Priyadarshini *et al*. (2020) observed that the highest specific growth rate 3.10 ± 0.07 observed at 25% inclusion of guar sprout meal and fish meal replacement in feed reported for tilapia fingerlings. El Sayed *et al.* (2016) concluded that specific growth rate significantly decreased with increasing guar meal levels beyond 20% for *O. niloticus* fingerlings. According to Chong *et al.* (2003) effect of soya bean meal as partial replacement of fish meal on juvenile discus showed specific growth rate decreased with the rate of soya ben meal inclusion. Feed consumption has also been reported to be affected by dietary protein content in *O. niloticus* (De Silva and Gunaskera, 1989). FCR was no significantly differed among the all treatment but the result obtained in T1 which was lowest 2.57± 0.03 compare with FCR reported for *Puntius gonionotus* fed with different plant based protein source based diet like maize meal diet (2.36), black gram husk diet (2.34), sunflower oil cake diet (2.23), mustard oil cake diet (2.28), green gram husk diet (2.31) Mohanta *et al.* (2006). According to Yen *et al.* (2015) *Puntius gonionotus* fish fed diets with 15 % plant based protein sources such as duckweed, cassava and water spinach showed 3.39, 3.65, 3.54 FCR, respectively. Reymend and Pagare,

Table 4. Proximate analysis of fish carcass composition

Experimental fish	Moisture (%)	Crude protein (%)	Ether extract (%)	Ash (%)
Before Experiment				
Initial fish sample	76.83±0.27	14.32±0.24	3.55±0.15	3.94±0.12
After Experiment				
T0	$76.16±0.11^{b}$	$16.26±0.09^{ab}$	$3.59±0.03^{a}$	$3.93±0.05^{a}$
T1	$75.97±0.08^{c}$	$16.67±0.12^{a}$	$3.63±0.09^{a}$	$3.68±0.05^{c}$
T2	$76.55±0.05^{a}$	$15.86±0.07^{bc}$	$3.62±0.04^{a}$	$3.71±0.04^{bc}$
T3	$76.66±0.10^{a}$	$15.64±0.07^{c}$	$3.61±0.08^{a}$	$3.78±0.10^{abc}$
T4	$76.67±0.04^{a}$	$15.59±0.14^{c}$	$3.61±0.03^{a}$	$3.87±0.03^{ab}$

Values are Mean ± SE of triplicate groups of control and four treatments. a, b, c, d, e values in the same row with different letters differ significantly ($p < 0.05$). Means were tested by ANOVA and ranked by Duncan's multiple range test.

(2016) reported that lower protein level resulted in higher feed conversion ratio and growth level of *P. ticto*. The proteins in both diets (diet I and diet II) were different, diet I contained 14.1% and diet II contained 34.1% proteins. In contrast Gandotra *et al.* (2014) conclude in the study that FCR decreased with increasing protein level although not significantly above 40% in catla fry. Similar trend in ornamental fish *nemacheliusbotia* reported by Gandotra *et al*. (2017). But in present study best FCR found with inclusion 25% roasted guar korma in diet compare with 20% inclusion of plant protein showed best FCR for *Oreochromis niloticus* (Al-Thobaiti *et al*., 2018).

The FER represents the weight of aquaculture production generated by 1 kilogram of feed. Study reported that 25% roasted guar korma contain diet showed highest feed efficiency ratio compared with channel catfish fed diets containing 5-10% fish meal had significantly greater weight gain and FE than fish fed a basal diet without fish meal and that supplementing catfish oil to the basal diet did not improve fish performance (Mohsen and Lovell, 1990). Feed efficiency improvement achieved by supplementing high levels of fish meal in the diet in those studies might partially be related to the high energy or fat content contributed by fish meal, improvement by the addition of low levels of fish meal might not be explained by the slight increase in energy or fat concentrations (Reymend and Pagare, 2016). According to Gandotra *et al.* (2017) investigated that the feed efficiency ratio was higher in the fish with diet containing 40% protein level showing the best utilization of the diet and lowest for 25% dietary protein. Further added that feed conversion efficiency increased with increasing protein level in the diet up to 40% in fry and then decreased afterwards. PER is influenced by dietary protein level and the effects vary with species. Protein quality and amino acid balance are used as an indicator of PER. T1 treatment resultant significantly highest 0.0653 ± 0.001 than other four treatments. With addition of plant protein source protein efficiency ratio decreased similarly Soltan *et al.* (2008) reported that replacement of fish meal by plant protein mixture showed negative effect with higher plant protein diet on protein efficiency ratio for *Oreochromis niloticus*. De Silva and Gunasekera (1989) stated that green gram could substitute for fishmeal in diets up to 37% protein level without any adverse effect and found that the substituted diets gave better result than the control diet at the 20% protein level and PER evaluated 2.99.

Hassan and Edwards (1991) reported that feeding duckweed to tilapia had a profound effect on carcass composition i.e. increase in carcass moisture and decrease in carcass lipid content. Similar results have been reported with higher level of dietary plant protein inclusions in common carp (Hossain and Jauncey, 1989) and rainbow trout (Yurkowski *et al*., 1978). Hussein *et al.* (2016) investigated that 50% of soybean crude protein can be replace by inclusion of 18.5% of guar korma meal without affecting growth performance and feed utilization of *O. niloticus*. The size of fish is associated with the protein content in fish fed on diets containing mainly plant proteins (Brinker and Reiter, 2011), where high correlation had been reported between wet weight and body protein content in fish (Dumas *et al.*, 2007). Study reported that level of increase in diet contain plant based protein source negative effect on ether extract content. Similar trend reported by de Francesco *et al.* (2004) replacing fish meal with plant proteins in the diet of rainbow trout showed a decrease in the body fat content. However, in contrast Yadollahi *et al.* (2018) reported that the fat content of the body significantly increased in 75% and 100% guar meal contain diet for as a substitute for soybean in rainbow trout.

When discussing the significance of fish in food and nutrition security in recent decades, research has mostly concentrated on the development of aquaculture.In a summary, the data shows that, from a nutritional aspect, species mostly from inland capture fisheries, particularly small indigenous species (SIS), have a higher potential for micronutrient consumption by vulnerable groups in the urban population (Prasanta Jana *et al.*, 2018). *P. ticto* also a small indigenous species found in all over Indian River basin. Till date there is no any small scale production unit of species. Species have ornamental as well as micro nutrient richfood values.

Under the experimental conditions of the present study, it was possible to reduce the use of fish meal by 25% due to inclusion of roasted guar korma, with an excellent growth performance of *Puntius ticto*. Diets based on roasted guar korma (RGK) were shown to be more cost efficient than diets based on fish meal. There are strong opportunities for creating fish feeds utilizing roasted guar korma as a source for partial substitution of fish meal protein since roasted guar korma is locally and readily ac-

cessible in Gujarat state at considerably cheaper rates than fish meal.

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