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COMPARISON OF EFFECTS OF COTTON SEED MEAL WITH FISH MEAL ON GROWTH, FEED CONVERSION RATIO AND SURVIVAL OF RED-BELLIED PACU (*PIARACTUS BRACHYPOMUS*)

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Abstract: Present study is carried out to compare the dietary effects of fishmeal and cottonseed meal on the growth, feed conversion ratio and survival of Red-bellied pacu *P. brachypomus*. Fish Meal (FM) and Cottonseed Meal (CSM) is used at three different protein levels (20%, 25% and 30%), basal supplemented with rice bran and maize. The growth performance of *P. brachypomus* was found to be highest when fed with diet FM25 (126.50gm) and the highest average weight gain was observed in CSM25 (17.42 ±0.17 g). The better food conversion ratio were recorded in treatment CSM30 (3.89 ±0.19). 100 % survival rates was observed in all the treatments.
Keywords: *Piaractus brachypomus*, Fish meal, Cottonseed Meal Growth, Food conversion ratio, Survival.

Introduction

The intensification of fish production in India has made it essential to develop complete and supplemental diets for use in aquaculture. Traditionally, fish meal is the preferred dietary protein source for many farmed fish species and is appreciated for its amino acid balance, vitamin content, palatability and un-identified growth factors [1]. However, increasing cost of fish meal has restricted its use as a protein source for fish diets. Therefore, plant proteins appear to be the most suitable alternatives for fish meal in fish diets.

Considering the high cost of fish meal in fish diets and over exploitation of wild fish, warrants the potential use of cottonseed meal (CSM) as an alternative source of high quality protein**.** Cottonseed, *Gossypium* spp, is the third leading legume seed by weight (after soybean and rapeseed) used worldwide due to its high protein value for animals (2) as well as low market price in comparison with legumes and fish meal. Cottonseed meal is an important source of dietary protein for domestic animals, its use in commercial aquaculture feeds is limited because of the presence of gossypol (a polyphenolic substrate) which known with its toxic effect in fish that include growth depression (3) and the low available lysine content. But this is overcome by Iron as ferrous sulfate, which is used to counteract the toxicity of free gossypol in diets of monogastric, terrestrial animals (4).

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Fig-1: *Piaractus brachypomus* (Red-bellied Pacu)

Different varieties of fishes have been introduced for aquaculture purposes throughout the world and such occurrences are common even today (5,6,7). Several exotic fish species have been introduced into Indian waters, the most recent of which are *Pangasius gariepinus* (African/Thai Magur) and *Pangasius sutchi* (pangus) and, there is the disturbing report of another fish, Pacu, which is also known as Red Pomfret and Roopchand (*Piaractus brachypomus*), entered into Indian aquaculture from Bangladesh. In India, pacu farming is developing atleast in one pond per village of Andhra Pradesh (8). Red-bellied pacu, *Piaractus brachypomus*, are high value species cultured for human consumption in Bolivia, Brazil, Colombia, Ecuador, Peru, and Venezuela.

As the culture of Pacu is fast developing and the protein requirement of pacu is least understood and depended on many factors such as species, size, protein source and quality, non-protein energy level in the test diets, feeding rate, water quality variables, natural food (9) hence the present was carried out to analyze and compare the growth, survival and Food Conversion Ratio (FCR) of pacu with six different feeds having different protein concentration.

Material and Methods:

Red-bellied Pacu (1.00±0.2 gm) was obtained from Fish Farmers at Bhimavaram, East Godavari District, Andhra Pradesh and acclimatized to laboratory conditions. This Experiment was performed in 60×30×40 cm aquarium tanks.

Experimental Diets:

Six isoenergetic diets were formulated to contain various percentages of protein levels i.e., 20%, 25% and 30%.. The composition and proximate analysis of experimental diets was given in Table-1 & 2.

Table -1. Feed formulation of the diets (Ingredients g/100g):

Ingredients	**FM20**	**FM25**	**FM30**	**CSM20**	**CSM25**	**CSM30**
Fish meal	20.00	31.50	43.00	--	--	--
Cottonseed meal	--	--	--	30.50	48.20	65.80
De-oiled rice bran	39.00	33.25	27.5	33.75	24.90	16.10
Maize	39.00	33.25	27.5	33.75	24.90	16.10
Vitamins and mineral mixture	2.00	2.00	2.00	2.00	2.00	2.00
Total	100	100	100	100	100	100

FM 20,25,30 = Fish meal Diet Containing 20% 25% and 30% Protein
CSM20,25,30 = Cottonseed Meal Diet Containing 20% 25% and 30% Protein

Table 2: Proximate composition of the ingredients (Per centage on dry matter basis)

Variables	**Fish meal**	**Cotton meal**	**Deoiled rice bran**
Moisture	7.03	7.69	7.70
Crude Protein	55.00	40.00	12.50
Ether extract	4.02	16.65	22.50
Total ash	3.47	3.53	3.90
Acid insoluble ash	5.60	4.24	15.80

Culture conditions

Each aquarium was stocked by 100 fish (1.00±0.2 gm). They were fed the diets at a daily rate of 8% (during the 1st month), then reduced to 7% (2nd month) and 6% (3rd month) of total biomass. Fish were fed every day of the week (twice daily at 9.00 am and 5.00 pm). The

amount of feed was bi-weekly adjusted according to the feed remaining in the aquaria throughout the experimental period (90 days). Water quality parameters are determined according to the methods of APHA(10). Ammonia and nitrite were measured at weekly intervals, while water temperatures, dissolved oxygen and pH were recorded in each tank fortnightly.

Sampling Procedure and Evaluation of Growth Parameters

For chemical analysis at the beginning and the at termination of the expeiment, the fishes were starved for 24 h. 15 fish from each tank were randomly collected for proximate analysis. Fish were killed by immersing in ice water. Fish carcass samples were analyzed for crude protein, crude fat, ash, and moisture according to the methods described by the Association of Official Analytical Chemists AOAC, 1990(11). Water content was measured by drying samples at 105ºC to constant weight in an oven. The data obtained were analyzed for feed conversion efficiency (FCR), protein efficiency ratio (PER), specific growth rate (SGR), using following formule:

$$\text{Feed Conversion Ratio } (\text{FCR}) = \frac{\text{Feed given } (\text{dry weight}) \ (\text{g})}{\text{Body weight gain } (\text{wet weight}) \ (\text{g})}$$

Specific Growth Rate (SGR) = [(L_n FBW - L_n IBW) / day] x 100

$$\text{Survival Rate } (\%) = \frac{\text{Total number of fish survived}}{\text{Total number of fish stocked}} \times 100$$

Statistical analysis

The data was analyzed using two-way ANOVA for completely randomized design, 9×9 factorial scheme was performed. Means of statistically different parameters and factors were compared by Tukey's test ($P < 0.05$). Pearson's correlation coefficient (r) values were utilized to evaluate possible interactions among parameters. Data were analysed with the aid of software WASP.

Results

Water Quality:

During the whole experimental period, water temperature ranged from 26.5^{0}C to 28.1^{0}C, dissolved oxygen from 5.7mg/l to 6.6 mg/l, pH from 7.6 to 8.1. There were no significant differences in water quality parameters among treatments during the whole experimental period indicating that, the experimental diets has not detrimental effects on the surrounding water quality of experimental fish.

Feed Conversion (Table-3):

The best Feed Conversion Ratio (FCR) was obtained in CSM30 (3.89 ±0.19) and the highest in CSM25 (4.42 ±0.25).(Table 3)

Table 3. Food conversion ration of Red-bellied Pacu (*Piaractus brachypomus*) fed on different experimental diets

Time	FM20	FM25	FM30	CSM20	CSM25	CSM30
10th	0.13± 0.07	0.11± 0.05	0.10± 0.03	0.13± 0.06	0.12± 0.04	0.13± 0.06
20th	0.48± 0.16	0.50± 0.16	0.45± 0.14	0.48± 0.20	0.45± 0.12	0.46± 0.11
30th	0.16± 0.15	1.53± 0.15	1.61± 0.14	1.35± 0.23	1.53± 0.19	1.40± 0.17
40th	1.46± 0.09	1.57± 0.07	1.72± 0.14	1.53± 0.14	1.50± 0.12	1.66± 0.41
50th	1.70± 0.16	1.95± 0.12	1.78± 0.11	1.65± 0.14	1.86± 0.12	1.73± 0.14
60th	3.56± 0.25	3.40± 0.23	4.17± 0.23	3.81± 0.17	3.48± 0.13	4.14± 0.21
70th	2.74± 0.18	3.08± 0.21	3.03± 0.19	2.58± 0.21	2.79± 0.15	2.64± 0.17
80th	4.04± 0.24	3.73± 0.21	4.56± 0.23	4.34± 0.24	3.40± 0.23	4.10± 0.24
90th	4.40± 0.34	4.10± 0.31	4.23± 0.29	4.08± 0.21	4.42± 0.25	3.89± 0.19

Growth Performance:

The six experimental diets has shown no significant difference between them on growth performance. The highest was recorded in diet FM25 (126.50±0.26) and followed by FM30 (126.01±0.34) and CSM25 (123.52±0.36) (Table 4).

Table-4: Growth Performance of Red-bellied Pacu (*Piaractus brachypomus*) fed on different experimental diets (g)

Duration (days)	FM20	FM25	FM30	CSM20	CSM25	CSM30
Initial	0.95± 0.03	1.00± 0.04	0.9± 0.05	0.95± 0.06	0.9± 0.05	1.00± 0.04
10th	7.23± 0.11	8.55± 0.10	8.75± 0.12	6.93± 0.11	7.35± 0.12	7.52± 0.19
20th	19.50± 0.19	22.50± 0.62	23.78± 1.02	18.53± 0.16	20.51± 0.18	20.67± 0.14
30th	29.82± 1.13	34.30± 1.26	35.62± 2.11	29.56± 0.11	31.25± 0.16	32.50± 0.14
40th	44.21± 0.96	49.65± 0.26	50.12± 0.83	43.16± 0.43	45.85± 0.13	46.23± 0.14
50th	62.51± 0.76	67.55± 0.43	69.89± 0.86	61.51± 0.21	63.12± 0.36	65.00± 0.33
60th	74.82± 0.23	79.50± 0.42	81.63± 0.51	72.82± 0.41	75.82± 0.21	76.00± 0.37
70th	91.23± 0.26	95.00± 0.31	97.81± 0.29	89.76± 0.32	92.13± 0.36	93.30± 0.51

80th	104.81± 0.22	110.30± 0.19	110.68± .32	102.18± .26	106.10± .43	107.00± .41
90th	119.12± 0.51	126.50± 0.26	126.01± .34	117.23± .33	123.52± .26	122.52± .36

Survival Rate:

At the end of the experiment there was 100% survival in all groups. The general health and appearance of all test fish were good and the fish in all treatments were very active.

Discussion

Sipauba *et al*., (1999)(12) stated that, 34% level of crude protein showed satisfactory results regarding the limnological characteristics studied in the dynamics of limnological characteristics in pacu culture tanks. This result suggested that the crude protein 25% is ideal for water quality parameters. Even though the recommended level for maintenance of adequate levels of water quality is 27% to 28% of crude protein.

Walter *et al*., (2011)(13) concluded that feed intake was higher in fish fed with the lowest dietary protein level and gradually diminished in fish fed with 32%. Low food consumption and high WG obtained in fish fed with 32% CP produced a FCR of 1.10 ±0.03, significantly better than that observed in fish fed with dietary protein levels above and below this level ($P<0.05$). Consequently, these theories could explain the higher feed ingestion by *P. brachypomus* fed diets isoenergetics with low protein. In the present study also experiment, the FCR value decreased as the dietary content of the protein increased. Gutierrez *et al*., (1996) observed a decrease in the FCR value from 3.9 to 2.4 when *P. brachypomus* fed with increasing dietary protein levels from 27 to 30%. It agrees with the present study, incase of plant dietary proteins, were also observed a decrease in the feed conversion ratio value from 4.42 to 3.89 (g) and 4.10 to 3.97 (g) when pacu fed with increasing dietary protein levels from 25 to 30%.

Data on growth increment show that there was a gradual increment in weight gain (46.5±5.0g) as dietary protein levels increased to 32% crude protein (CP). Fish fed with diet beyond 36% crude protein could not produce additional growth. There is some evidence that at very high feeding levels, protein deposition tends to level off (plateau) (14). Fish fed diets with lower CP levels showed reduced weight gain and efficiency of feed utilization. Dietary protein is the most important factor affecting growth performance of fish and feed cost. The demand of fish protein for growth is different according to species, feeding habits,

physiological and development state, conditions of culture, sources of protein, dietary energy levels and the protein: energy ratio (15).

In the present study, 25% protein diet showed remarkable growth than 20% and 30% of all the three diets i.e., fish meal, groundnut cake, cottonseed meal. It agrees with the results of Borghetti & Canzi (1993)(16) who recommended the 27% to 28% of crude protein is good for pacu growth and maintenance of adequate levels of water quality.

Cottonseed meal usually contains 0.4 to 1.7% gossypol. Free gossypol, when present in large quantity in the diet, has been shown to be toxic to mono-gastric animals including fish (17). The present study agrees with this because the diet with 25% CSM gave highest growth than 30% CSM diet.

This study agrees with the Francis *et al*., (2001)(18), that about 30% to 50% of fish meal (FM) can be successfully replaced in fish feeds by plant protein sources. From economic standpoint, replacement of FM completely or partially with cheaper cottonseed meal in a practical diet for Red-bellied Pacu can alleviate the problem of low FM availability and high cost, because the fishes fed with CSM were performed well with slight variations to fishes fed with FM. The results of this experiment suggest that a diet containing 25% crude protein with 48% CSM was adequate for normal growth in Red-bellied Pacu.

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