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Study the use of Cassava Tuber Powder as Replacement of Carbohydrate in the Diet of Genetically Improved Farmed Tilapia

Sydur Rahman[1], Ahsan Bin Habib[2], Solaiman Fakir[3], Abdul Halim[4]

[1]Upazilla Fisheries Officer, Department of Fisheries, Government of the People's Republic of Bangladesh, [2]Professor, Dept. of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, [3]Professor, Dept. of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, [4]Scientific Officer, Bangladesh Fisheries Research Institute (BFRI), Bangladesh

Abstract

The experiment was conducted to determine the use of cassava tuber powder (CTP) as replacement of carbohydrate in pelleted feeds on the growth, survivability, and production of genetically improved farmed tilapia (GIFT) (*Oreochromis niloticus*) for 56 days in 15 recirculatory aquaria in Wet Laboratory at the Department of Aquaculture, Bangladesh Agricultural University, Mymensingh. For the experiment, 600 fingerlings (initial weight of 1.30 ± 0.10 g) were released at the same stocking density (40 fingerlings per aquarium). Five different treatments such as T_1, T_2, T_3, T_4, and T_5 (control) each with three replications were used. Diets were formulated containing different levels of CTP, T_1: 10%, T_2: 15%, T_3: 20%, T_4: 25%, and T_5: 0% CTP (control). Feeds were supplied at 6% body weight twice daily. The final weight (g), weight gain (g), percentage weight gain (%), specific growth rate (SGR) (%/day), and average daily weight gain of tilapia varied significantly ($P < 0.01$). Highest feed conversion ratio (FCR) (2.15 ± 0.09) was found in T_5, and the lowest FCR (2.08 ± 0.08) was found in T_3. The highest protein efficiency ratio (PER) (1.99 ± 0.012) was found in T_2, and the lowest PER (1.54 ± 0.20) was found in T_1. The highest survival rate (88.80 ± 0.61) was found in T_4, and lowest survival rate (83.91 ± 1.52) was found in T_5 (control). The growth performance was found significantly ($P < 0.01$) higher in T_3 followed by T_2, T_4, T_1, and T_5. The present research findings suggested that diet formulated by CTP as replacement of carbohydrate might be used to prepare quality feed to enhance the growth, production, and survivability of GIFT (*O. niloticus*) and to reduce pressure on starch of wheat and rice.

Keywords: Cassava Tuber Powder; Carbohydrate; Genetically Improved Farmed Tilapia; Feed Conversion Ratio; Protein Efficiency Ratio; Growth Performance

1. Introduction

Over the past decades, globally aquaculture has grown in leaps and bounds in response to an increasing demand for fish as a source of protein (Akinrotimi et al., 2007). This is because production from capture fisheries has reached its maximum possible potential as the catch is dwindling with each passing day (Gabriel et al., 2007). Feed cost is one of the largest operational costs in aquaculture (De Silva 2001). About 70% cost of fish production by aquaculture is needed for feed cost. Animal protein supplements are the foundation of any aquaculture feed formulation (Akiyama 1991). The need to intensify the culture of fish so as to meet the ever-increasing demand for fish has made it essential to develop suitable diet either in supplementary forms for ponds or as complete diet in tanks (Olukunle 2006).

Cassava (*Manihot esculenta*) is widely grown in the tropics and is utilized by man and animals. It is a staple food for many Africans, and various fast-growing cultivars have been developed. The production of cassava for human consumption has been estimated to be 65%, while 25% is for industrial use (mostly as starch 6% or animal feed 19%) and 10% lost as waste (Fish and Trim 1993; Oluwole et al. 2004; Maxiya et al. 2007). Cassava has a high production potential (fresh tuber yield, 40–60 tons/ha), whereas maize and wheat yielded (20–25 tons/ha) respectively. Cassava tuber can be used to make flour with an energy value of more than 3000 MJ of metabolizable energy per kg (Stevenson and Jackson, 1983; Kirchgessner 1993). Its tuber contains significant amounts of calcium (50 mg/100 g), phosphorus (40 mg/100 g), and Vitamin C (25 mg/100 g). According to composition values, cassava tuber powder (CTP) contains 15.37% moisture, 1.55% crude lipid, 2.15% ash, 1.75% crude protein, 1.40% crude fiber, and 77.78% carbohydrate on moisture basis (Sriroth et al., 2000). Cassava tubers are generally rich in calcium and ascorbic acid and contain significant amounts of thiamine, riboflavin, and niacin (Pedrosa 2002). CTP has been reported to be cheaper than maize and wheat (Egan and Henry, 1985). Thus, they reduced feed cost and maintain production. The hydrogen cyanide (HCN) is almost removed during processing, and it may depress chick performance and feed intake due to palatability problems (Nweke et al., 1994). Sun drying the peeled cut pieces of tubers gave a HCN concentration lower than 10 mg/100 g and loss was more effective than oven drying (Mahungu et al., 1987). The tuber of cassava is used to prepare cassava tuber meal. Many research works have already been conducted in the world on this issue as global utilization of cassava tuber powder as replacement of carbohydrate. But the research work is very scanty in our country. However, the research work is very scanty in our country. Therefore, the present study was undertaken to evaluate the feasibility of replacement CTP as carbohydrate source in feed of tilapia fingerlings under monoculture system.

2. Materials and Methods

2.1. Experimental design

Fifteen rectangular glass aquaria (45 cm × 40 cm × 35 cm) of 50 L capacity containing about 40 L of water were used as experimental tanks. Net screen gravel was used as biofilter. For convenience, the tanks were numbered as T_1R_1, T_1R_2, and T_1R_3; T_2R_1, T_2R_2, and T_2R_3; T_3R_1, T_3R_2, and T_3R_3; T_4R_1, T_4R_2, and T_4R_3; and T_5R_1, T_5R_2, and T_5R_3.

2.2. Collection of fry

Fingerlings of genetically improved farmed tilapia (GIFT) (*Oreochromis niloticus*) belong to the same age group (35 days) having average body weight of 1.30 ± 0.10 g through proper handling.

2.3. Acclimatization of fry

After receiving at the laboratory, the fingerlings were given an iodine treatment with 0.5% NaCl solution for 7 days in 10 aquariums with sufficient aeration.

2.4. Experimental procedure

The experiment was conducted in 15 glass aquaria with five treatments each having three replications.

2.5. Feed formulation

All five diets had a constant inclusion level of the following ingredients: Fish meal (56% protein), soybean oil, wheat flour, carboxymethyl cellulose, vitamin and mineral premix, and chromic oxide. Attempts were made to formulate diet by progressively replacing cassava root powder as carbohydrate source. Diets 1, 2, 3, and 4 were replacing, respectively, 10%, 15%, 20%, and 25% carbohydrate by CTP. Diets 5 containing 0% cassava root powder was used as control. While formulating the diets, essential fatty acid contents were taken into consideration by adjusting soybean oil. Diets were subjected to proximate composition analysis, and results are presented in Tables 1-5.

2.6. Feeding strategy

The fishes were fed with the formulated diets twice daily in the morning at 9.00 am, then 1.00 pm, and afternoon at 5.00 pm throughout the study period.

Table 1: Proximate composition analysis of different feed ingredient (% moisture basis)

Name of ingredients	Moisture (%)	Crude protein (%)	Crude lipid (%)	Crude fiber (%)	Ash (%)	Carbohydrate (%)
Fish meal	10.75	56.00	11.26	4.80	13.85	3.34
Cassava root powder	15.37	1.75	1.55	1.40	2.15	77.78

Table 2: Formulation (% dry matter basis) for 100 g feed of the experimental diets used in the experiment

Ingredients (g)	Diet No.				
	1 10% CTP	2 15% CTP	3 20% CTP	4 25% CTP	5 Control
Fish meal (56% protein)	53	53	53	53	51
Cassava (78% carbohydrate)	13	19	25	32	0
Soybean oil	5	5	5	5	5
Wheat flour (binder)	15	11	7	2	26
Alpha cellulose (crude fiber)	8	6	4	2	12
Mineral premix	3	3	3	3	3
Vitamin premix	2	2	2	2	2
Chromic oxide	1	1	1	1	1
Total	100	100	100	100	100

CTP: Cassava tuber powder

Table 3: Proximate composition of the formulated diet (% moisture basis)

Components (%)	Diet No.				
	1	2	3	4	5
Moisture	13.25	12.88	12.30	12.59	13.07
Crude protein	29.02	29.40	30.70	30.10	29.14
Crude lipid	8.75	10.60	9.79	11.01	10.12
Crude fiber	6.20	5.47	5.59	4.69	5.85
Ash	12.37	11.41	11.92	12.54	12.05
Carbohydrate	30.41	30.24	29.70	29.07	28.97

2.7. Sampling procedure

Sampling of the experimental fish was done randomly at an interval of 7 days to check water quality parameters and the growth performance of fish.

2.8. Determination of carcass composition

At the beginning of the experiment, 200 fish from the stock were randomly collected and sacrificed, then chopped, and ground for proximate composition analysis of the experimental fish. This was considered as initial carcass composition of fish. At the end of the experiment, 10 fish per replication including the control were sampled randomly and sacrificed for final proximate composition analysis, and this was considered as final carcass composition of fish. Proximate composition of fish included moisture, crude protein, crude fiber, and ash.

Table 4: The effect of different treatments on growth performance, feed utilization and survival of stinging GIFT (Oreochromis niloticus) in aquarium (Mean ± SE) during the study period.

Variables parameters	Treatments (mean ± SE)						
	Treatment 1	**Treatment 2**	**Treatment 3**	**Treatment 4**	**Treatment 5**	**LSD**	**Level of significance**
Initial weight (g)	1.30 ± 0.00	1.30 ± 0.00	1.30 ± 0.00	1.30 ± 0.00	1.30 ± 0.00	-	ND
Final weight (g)	6.53 ± 0.02^{b}	6.59 ± 0.17^{b}	6.89 ± 0.02^{a}	6.54 ± 0.08^{b}	6.47 ± 0.04^{b}	0.088	**
Weight gain (g)	5.23 ± 0.02^{b}	5.29 ± 0.17^{b}	5.59 ± 0.02^{a}	5.24 ± 0.08^{b}	5.17 ± 0.04^{b}	0.088	**
Percent weight gain (%)	402.31 ± 1.18^{b}	406.92 ± 3.14^{b}	430.00 ± 1.57^{a}	403.08 ± 2.34^{b}	397 ± 4.11^{b}	6.91	**
Specific growth rate (%/day)	2.88 ± 0.00^{b}	2.90 ± 0.05^{b}	2.98 ± 0.00^{a}	2.88 ± 0.02^{b}	2.86 ± 0.01^{b}	0.033	**
Average weight gain	0.093 ± 0.003^{b}	0.094 ± 0.002^{b}	0.100 ± 0.001^{a}	0.094 ± 0.005^{b}	0.092 ± 0.003^{b}	0.011	**
FCR	2.09 ± 0.09	2.12 ± 0.12	2.08 ± 0.08	2.09 ± 0.001	2.15 ± 0.09	0.015	NS
PER	1.54 ± 0.20^{c}	1.99 ± 0.012^{a}	1.93 ± 0.03^{b}	1.98 ± 0.002^{a}	1.93 ± 0.20^{b}	0.092	**
Survival rate (%)	85.67 ± 1.88^{ab}	87.25 ± 0.43^{a}	88.02 ± 1.06^{a}	88.80 ± 0.61^{a}	83.91 ± 1.52^{b}	1.288	**

ND: Note done, NS: Not significant, **1% Level of significance. PER: Protein efficiency ratio, FCR: Food conversion ratio, GIFT: Genetically improved farmed tilapia, SE: Standard error, LSD: Least significant difference

2.10. Analytical methods

Proximate composition of the experimental feed used and its ingredients and fish sample were analyzed in triplicate according to standard procedures given in the Association of Official and Analytical Chemists (AOAC, 1990).

2.11. Statistical analysis

One-way analysis of variance was used to determine the effect of formulated diets on the growth of GIFT in different treatments. For this purpose, the percent data were converted to arcsine and then applied for analysis. This was followed by Duncan's new multiple range test, to identify the level of significance of variance between the treatments. Computer analysis of data was performed using the software SPSS version 11.5 (Chicago, USA) and MS Excel 2007 (Microsoft Corporation, Redmond, USA).

3. Results [Table 4-6, Figures 1 and 2]

Table 5: Cost of different dietary ingredients (Tk./kg) used to formulate feed

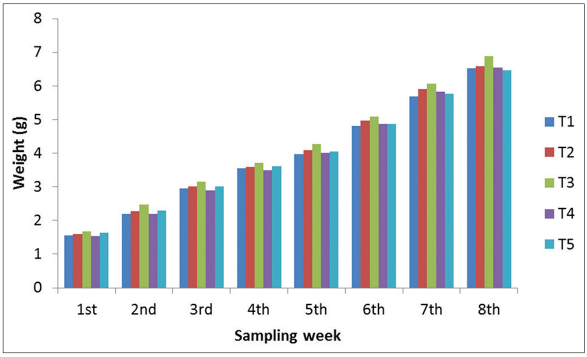
Ingredients	Cost (Tk./kg)
Fish meal	90
Cassava tuber powder	20
Soybean oil	65
Wheat flour (binder)	35
Alpha cellulose (crude fiber)	30
Mineral premix	500
Vitamin premix	500

Table 6: Cost of different formulated diet (Tk./kg) used in the experiment

Diet	Cost (Tk./kg)
Diet - 1 (10% CTP)	46
Diet - 2 (15% CTP)	45
Diet - 3 (20% CTP)	44
Diet - 4 (25% CTP)	43
Diet - 5 (0% CTP) control	46

Price of local market and an additional 7.5% on the top of the total raw material cost has been included. CTP: Cassava tuber powder

Figure 1: Weekly growth response of genetically improved farmed tilapia (*Oreochromis niloticus*) in different treatments during the study period



4. Discussion

Water temperature of the aquarium water was recorded which ranged from 26.7°C to 30.60°C in both control and treatment aquaria similar (Hossain, 2009; Alam; 2009; Hossain et al., 2004; Hossain et al., 2007). The dissolved oxygen content from the present experiment ranged from 6.00 to 8.20 mg/l (Do, 1996; Hossain, 2009; Alam, 2009). During the study period, the pH value was found within the range of 7.0–8.0 (Do, 1996; Hossain, 2009; Alam, 2009).

The values of survivability were observed as 85.67%, 87.25%, 88.02%, 86.80%, and 83.91% in treatments T_1, T_2, T_3, T_4, and T_5, respectively. The highest survival rate was recorded in T_3 and the lowest survival rate was recorded in T_5. Dan and Little (2000) also reported more or less similar level of mortality. The highest mean weight gain was found from T_3 (5.59 ± 0.02 g), whereas the lowest mean weight gain was found from T_5 (5.17 ± 0.049 g). The results indicated that the growth rates varied in different treatments which coincide with the findings (Khan et al., 2002). The highest weight gain was found from treatment T_3 due to the utilization of 20 % cassava formulated feed. The values of SGR of GIFT tilapia in treatment T_1, T_2, T_3, T_4, and T_5 were 2.88 ± 0.00, 2.90 ± 0.05, 2.98 ± 0.06, 2.88 ± 0.02, and 2.86 ± 0.01 which were different from each other. The highest SGR values were in the treatment T_3 (20% cassava) and the lowest SGR values in the treatment T_5 (control). There was no significant difference ($P < 0.05$) among the different treatments. This value is more or less similar with the findings (Azad et al., 2004) but slightly lower than the findings (Hossain et al., 2007) achieved the SGR ranged between 3.14 and 3.32. The feed conversion ratio (FCR) in treatment T_3 (20% cassava) was 2.08 which was the lowest amount of food taken by fish which gave highest growth. The FCR values of the treatment T_5 (control) was 2.15 where fishes taken highest amount of food and gave lowest growth.

5. Conclusion

Most of the values of this investigation were significant ($P < 0.05$). From above findings, the experiment revealed that the best growth performances, feed utilization, survival rate, and production of GIFT *(O. niloticus*) were obtained at 20% CTP (cassava tuber powder). Finally, it was concluded that the diet containing 20% CTP produced quality fish by reducing production cost. For better understanding, more research is needed because cassava tuber is a good source of carbohydrate other than rice bran or wheat flour which made economically viable and environmentally friendly.

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