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Young turmeric (*Curcuma longa*) tuber as feed additive for the growth and survival of Nile tilapia (*Oreochromis niloticus* L.)

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Abstract

Turmeric is a well-known as a indigenous herbal medicine having a wide range of pharmacological activities and the best studied natural compounds. The study was conducted to determine the growth and survival of Nile tilapia fingerlings fed with powdered young turmeric tuber as feed additive for a period of 60 days in aquarium condition. The treatments of the study were 0%, 2%, 4% and 8% levels of added powdered young turmeric on the diet of Nile tilapia. Proximate analysis revealed that experimental diets contained levels of crude protein and carbohydrates ranging from 5.3% to 5.4% and 67.5% to 67.6% respectively. Results of the study showed that utilization of powdered young turmeric tuber up to 4% level of incorporation enhanced the growth performance of Nile tilapia. Further, improved survival was attained on the fish fed with powdered young turmeric tuber that those fed with commercial feed. The study concluded that young turmeric tuber can be utilized as a growth promoter feed additive and can improve the survival of Nile tilapia.

Keywords: Growth performance, Nile tilapia, survival, turmeric, proximate analysis

1. Introduction

Aquaculture is the fastest growing industries around the world with about 80 million tons being produced annually (Kolkovski and Kolkovski, 2011) ^[12]. Nile tilapia have become an excellent choice for aquaculture (El-Sayed, 2006) ^[8]. Nile tilapia is an important freshwater fish species for aquaculture because of its admirable characteristics such as fast growth, high muscle production and stable genetic character (Dey and Gupta, 2000) ^[6]. Different studies were conducted to minimize fish feed costs by using medicinal plants as feed additives instead of using synthetic drugs of serious side effects (Flück *et al.*, 1976) ^[11].

Medicinal plants as immune-stimulants can be used not only against disease but also as growth promoters, stress resistance boosters and preventative of infections (Bastardo *et al.*, 2012) ^[2]. The principles of organic aquaculture encourage the development of fish feeds containing fish meal from sustainable fisheries only to avoid depleting global fish stocks and stresses the need for alternative, organic feed ingredients (EU, 2007, 2009) ^[9, 10]. The development of new species-specific diet formulations supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe, and high-quality fish and seafood products (Craig and Helfrich, 2002) ^[5].

The last few decades, extensive work has been done to establish the biological activities and pharmacological actions of turmeric and its extracts (Chattopadhyay *et al.*, 2004) ^[4]. There are several reports indicating a wide range of pharmacological activities of turmeric reported as anti-microbial (Negi *et al.*, 1999) ^[19], anti-tumor (Ozaki *et al.*, 2000) ^[20], anti-allergic (Yano *et al.*, 2000) ^[27], anti-inflammatory (Surh *et al.*, 2001) ^[26] and antioxidant (Masuda *et al.*, 2002) ^[18]. It is also strongly alleged that turmeric can improve digestion and nutrient metabolism and this beneficial effects are related to atsiri oil and curcumin content (Al-Sultan and Gameel, 2004) ^[1].

The study aimed to determine the nutritive value of powdered young turmeric tuber and to assess the effectiveness of powdered young turmeric (*Curcuma longa*) tuber as feed additive on the growth and survival of Nile tilapia (*O. niloticus* L.) fingerlings. It also aimed to determine the optimum level of powdered young turmeric tuber that will promote better growth and survival.

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2. Materials and Methods

2.1 Supplementation of Powdered Young Turmeric Tuber to the Fish Feeds

Young turmeric (*Curcuma longa*) tuber were obtained from a single source bought from the local market. After peeling, young turmeric tuber were cut into small pieces and oven dried at 40°C for 7 hours. Dried young turmeric tuber were pulverized using a pulverizer. Four diets were used and served as the treatments of the study: Treatment I contained only fry mash (control); Treatment II is composed of 2% of powdered young turmeric tuber added to fry mash; Treatment III with 4% and Treatment IV with 8%. The powdered young turmeric tuber was mixed to the fry mash using a mixer and basin. The feed mixture was kept in air-tight plastic containers, labelled and stored at room temperature.

2.2 Experimental Fish and Experimental Set-up and Feeding Process

A total of 144 Nile tilapia fingerlings of FaST strains with initial weight ranging from 9 to 12 grams were used in the study. The fingerlings were obtained from the Freshwater Aquaculture Center, Central Luzon State University (FAC-CLSU), Philippines. Before the start of the experiment, the fingerlings were acclimatized for 7 days and starved within 24 hours. Twelve rectangular aquaria each measuring 60 x 30 x 30 cm were used as the experimental units in the study. The fish were randomly distributed into the aquaria at a stocking density of 12 fingerlings per aquarium. Aeration, cleaning of aquaria and changing of water were administered to maintain good water environment for the fish. Feeding was done twice a day at 9:00 in the morning and 3:00 in the afternoon. Ten percent feeding rate was initially used and reduced to five percent after 60 days. The ration was adjusted every 15 days where new mean weights of fish were determined through sampling.

2.3 Statistical Analysis

Significant differences in initial weight, final weight, final length, body weight gain, specific growth rate, survival rate and condition factor (K) were analyzed using one-way analysis of variance (ANOVA) of R Software. The data on the survival rate was arcsine transformed to make the data conform to normality. Comparison of means was done using Duncan Multiple Range Test at significant level of ($P < 0.05$).

2.4 Proximate Composition of Powdered Young Turmeric Tuber

Proximate analysis of the powdered young turmeric tuber was analyzed at Philippine Rice Research Institute (PhilRice), Rice Chemistry and Food Science Division, Science City of Muñoz, Nueva Ecija, Philippines. All analyses were duplicate thrice. The proximate values were reported in percentage. The crude protein content was determined using the Kjeldahl method ($N \times 6.25$). The crude lipid content was determined using the Goldfisch method by extraction with petroleum ether. The moisture content was determined using a drying oven at 40 degree Celsius for six hours. Ash was determined by incineration of a pre-weighed sample in a silica crucible in a muffle furnace at 600 degree Celsius for three hours. Crude fiber was obtained by the acid alkaline method. Total soluble carbohydrate was determined by the difference of the sum of all the proximate compositions from 100%.

3. Results and Discussion

Growth is an indicator of good health of both individual and populations and it can be determined as the change in size, length and weight of the fishes. Table 1 summarizes the growth parameter evaluated in the experiment. The highest final average weight was obtained in fish fed with 2% (Treatment II) and 4% (Treatment III) powdered young turmeric tuber with a value of 49.41 ± 2.53 g and 51.39 ± 9.61 g. Statistical analysis revealed that Treatment II and Treatment III were significantly higher ($P < 0.05$) compared to the control diet (Treatment I) with an average final weight of 38.50 ± 1.45 g. Moreover, control diet revealed to be comparable to fish fed with 8% powdered young turmeric tuber (Treatment IV) with a value 39.33 ± 2.85 g. The enhanced growth response among treatments with turmeric supplementation may be due to improved feed consumption, feed utilization and increased nutrient digestibility (Yitbarek, 2015)^[28].

The highest final length was noted in 4% (Treatment III) with 13.52 ± 0.79 cm and 2% (Treatment II) with 13.52 ± 0.27 cm followed by 8% (Treatment IV) with 12.54 ± 0.24 cm and control diet (Treatment I) with 12.45 ± 0.15 cm. Statistically analysis showed that 2% (Treatment II) and 4% (Treatment III) powdered young turmeric tuber were comparable but significantly higher ($P < 0.05$) compared to control diet (Treatment I) and 8% (Treatment IV).

The highest average of body weight gain was recorded in fish fed with 4% (Treatment III) powdered young turmeric tuber with a value of 40.61 ± 9.55 g. However, statistical analysis revealed that 4% (Treatment III) is not significantly different to 2% (Treatment II) with an average gain in weight of 38.69 ± 2.35 g. Further 2% (Treatment II) and 4% (Treatment III) were significantly higher ($P < 0.05$) compared to control diet (Treatment I) with a value of 27.81 ± 1.60 g but attained comparable result to 8% (Treatment IV) with a value of 28.56 ± 2.94 g. In the study of Platel and Srinivasan, 2004; Durrani *et al.*, 2006,^[21, 7] dietary supplementation of curcumin exhibited a significantly positive effect on weight gain and feed efficiency at marketing age when they validated positive effect of curcumin on broiler growth performance. Curcumin is considered as a prebiotic that can improve the balance of positive and negative intestinal flora (Kurhekar, 2013)^[13] and it can increase the intestinal digestion and absorption that leads to stimulate the growth and improve the general health of fish (Canosa *et al.*, 2007)^[3].

The highest specific growth rate was recorded in Treatment III with a value of 3.87 ± 0.20 % and seconded by Treatment II with 3.84 ± 0.05 %. This was followed by Treatment IV with a 3.59 ± 0.08 % and the lowest in Treatment I with 3.57 ± 0.04 %. The specific growth rate revealed that Treatment II and Treatment III were comparable to each other but were significantly higher ($P < 0.05$) compared to Treatment I and Treatment IV ($P < 0.05$).

The highest percent survival was recorded in 4% (Treatment III) powdered young turmeric however, statistical analysis showed that 2% (Treatment II), 4% (Treatment III) and 8% (Treatment IV) powdered young turmeric tuber are insignificant with each other with a value of 91.67 ± 8.91 , 95.00 ± 7.58 and 94.44 ± 8.13 respectively. Further, the study revealed that fish fed with powdered young turmeric tuber attained better survival than fish fed with commercial feed as significantly higher ($P < 0.05$) survival was recorded to 2% (Treatment II), 4% (Treatment III) and 8% (Treatment IV) compared to control diet (Treatment I) with a value of

82.78±18.49. In the study of Sahu *et al.*, (2011), turmeric feeding may elevate the non-specific immune system and give long term protection. Its antioxidant effect was eight times more powerful than vitamin E (Reddy and Lokesh, 1992)^[23]. Condition factor (K) is an important parameter which represents well-being and fitness of fish. The fish which is heavier at particular length is considered to be in better

condition (Nash *et al.*, 2006)^[18]. The study showed a condition factor (K) of Treatment III (2.00±0.15), Treatment II (1.97±0.13), Treatment IV (1.94±0.25) and Treatment I (1.84±0.44). However, no significant differences are noted in all treatments. According to Le Cren (1951)^[14] K values greater than 1 indicated good condition of the fish whereas a value <1 is indicative of the reverse nature.

Table 1: Growth parameters (± standard deviation) of the experimental fish per treatments in 60 days feeding duration

Parameters	Treatments			
	I	II	III	IV
Initial Weight (g)	10.69 ^a ±0.19	10.72 ^a ±0.24	10.73 ^a ±0.06	10.77 ^a ±0.09
Initial Length (cm)	8.55 ^{ab} ±0.09	8.48 ^{ab} ±0.11	8.72 ^a ±0.11	8.61 ^b ±0.15
Final Weight (g)	38.50 ^c ±1.45	49.41 ^{ab} ±2.53	51.39 ^a ±9.61	39.33 ^{bc} ±2.85
Final Length (cm)	12.45 ^b ±0.15	13.52 ^a ±0.27	13.52 ^a ±0.79	12.54 ^b ±0.24
Body Weight Gain (g)	27.81 ^c ±1.60	38.69 ^{ab} ±2.35	40.61 ^a ±9.55	28.56 ^{bc} ± 2.94
SGR (%)	3.57 ^b ±0.04	3.84 ^a ±0.05	3.87 ^a ±0.20	3.59 ^b ±0.08
Survival Rate (%)	82.78 ^b ±18.49	91.67 ^a ±8.91	95.00 ^a ±7.58	94.44 ^a ±8.13
Condition Factor (K)	1.84 ^a ±0.44	1.97 ^a ±0.13	2.00 ^a ±0.15	1.94 ^a ±0.25

Means in rows with different letters are significantly different at 5% level of significance.

Proximate analysis (Table 2) revealed that powdered young turmeric tuber contains 14.0% moisture, 6.5% crude ash, 5.4% crude protein, 1.9% crude fat, 4.7 % crude fiber and 67.6% carbohydrates. This implies that powdered young turmeric tuber can supply high level of carbohydrates and it can also supply protein. The 6.5% crude ash content of turmeric shows that powdered young turmeric tuber contain reasonable amount of mineral. In the study of Rojtinnakorn *et al.*, (2012)^[24] showed that turmeric extract fed had significant higher specific digestive activities that affects the

enhanced growth rate of Nile tilapia. This finding is in line with the report of Prasad and Aggarwal (2011)^[22] which revealed that *Curcuma longa* is a good digestive stimulant that promotes the activities of enzymes like amylase, chymotrypsin and lipase. Also, this study disclosed similar view with Sahu *et al.*, (2011)^[25], Mahmoud *et al.*, (2014)^[16] who reported that inclusion of *Curcuma longa* improved the growth performance of *Labeo rohita* and *Oreochromis niloticus*.

Table 2: Proximate composition of powdered young turmeric tuber

Sample	Proximate Content (%)							Total
	Moisture	Crude Ash	Crude Protein	Crude Fat	Crude Fiber	Total Carbohydrates		
Young Turmeric (Replicates)	1	13.9	6.5	5.4	1.9	4.7	67.6	100%
	2	14.0	6.5	5.3	2.0	4.7	67.5	100%
	3	14.0	6.5	5.4	1.9	4.6	67.6	100%
Average	14.0	6.5	5.4	1.9	4.7	67.6	100%	

4. Conclusions

The results obtained in the present study demonstrated that powdered young turmeric tuber as a feed additive is a potential alternative solution as a growth promoter and improving survival in fish. It is concluded that the powdered young turmeric tuber inclusion had positive influence on the growth performance and survival of the fish. Further, study recommends the utilization of 4% level of incorporation powdered young turmeric tuber as feed additive on the diet of Nile tilapia (*O. niloticus* L) to have a healthy outlook profile to consumer besides its prime benefit of reducing the feed cost and organically raised aquaculture species.

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