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EFFECT OF CYCLES OF FEED DEPRIVATION ON COMPASATORY GROWTH OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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ABSTRACT

Nile tilapias (*Oreochromis niloticus*) weighing 2.669±1.713 g (mean±SD) were kept in glass aquarium for 8 weeks. The experiment was divided into two cycles i.e. non feeding period (NFP) and feeding period (FP). The fish were deprived of feed in 1st, 2nd and 4th week while feed was given in 3rd, 5th, 6th, 7th and 8th week. At the end of week 1 and 2, the fish had significantly lowered body weight (-15.7%). Week 3rd was subjected to feeding and fish were further decrease the body weight (-18.3%). Compensation in weight was begun in 4th week although the fish were deprived of feed. During four consecutive feeding weeks they exhibited gradual compensation followed by highly significant increase in weight (week 7th, 52.7% & week 8th 66.9%). The specific growth rate (SGR) of experimental fish in feeding cycles were significantly higher than non feeding cycle, suggesting that hyperphagia was the mechanism responsible for increased growth rate during cycle of deprivation. The amount of moisture, protein, lipid and ash did not differ significantly throughout the experiment.

Keywords: *Oreochromis niloticus*, compensatory growth, feed deprivation,

INTRODUCTION

Compensatory growth is a term used to describe a period of increased growth rate, which occurs following a growth restriction imposed earlier. An animal whose growth has been showed by nutritional deprivation may exhibit an enhanced rate of growth when realimented. If this exceeds the maximal rate of gain when adequate nutrition has been provided, the animal is said to have undergone compensatory or catch-up growth. (McMurtry *et al*, 1988). This compensatory response has been described for many fish species (Miglavs and Jobling, 1989; Xie *et al*, 2001) including Nile Tilapia. (Melard *et. al*, 1997; Takagi, 2001). Aquaculturist are aware of the phenomenon of compensatory growth. In essence, this is a phase of rapid growth, greater than normal growth rates associated with adequate refeeding of fish following a period of weight lost caused by under nutrition. Many attentions have been focused on the phenomenon of compensatory growth, mainly in commercial fish species, since it can be so intense that fish exhibit a higher growth rate than those continuously fed. This represents a greater fish weight gain, as reported for sunfish by Hayward *et al*, (1997). For this reasons, studies have been conducted on the factor that modulated this phenomenon such as duration of food restriction, age, species-specific differences, previous nutritional status (Boujard *et al*, 1997) and grouping. Since Nile Tilapia is the most extensively cultured cichlid in the world, understanding the factors that modulate compensatory growth in this specie is extremely important goal for aquaculture management. These operational indicators of growth chosen to estimate better compensation were weight, specific growth rate, food conversion ratio and food intake, all being well establish indicators of compasatory growth in fish. (Ali and Wooton, 2000; Jobling and Koskela, 1996).

MATERIALS AND METHODS

The experiment was carried out in glass aquaria having the dimension of Depth 1.5' x Length 3' x Width 1.5' between 10 February to 30 March 2004 at the department of Zoology, University of Karachi using Nile tilapia (*O. niloticus*) obtained from interior Sindh, Pakistan. All specimens were weighed (2.669±1.713 gm.) and acclimated to laboratory conditions for 48 hours. They were deprived of any kind of food to clear the gut.

The experiment lasted for 8 weeks and was divided into two cycles named as non feeding period (NFP), weeks 1 to 2 & 4 and feeding period (FP), weeks 3 & 5 to 8. Week 1st, 2nd, and 4th were subjected to NFP while week 3rd, 5th, 6th, 7th and 8th were subjected to FP as described by Wang *et al.*, 2000. Prior to the start of experiment, an artificial diet was formulated (Table 1) containing 31.2% crude protein, 3.2% lipid, 16.2% ash and 15.6 K.cal/100g energy. During feeding periods they were fed twice a day @ 5% of body weight in morning and evening. The faeces were collected from each aquarium by pipetting, dried at 70°C to constant weight at 5°C.

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Proximate analysis

Crude protein in the feed was determined by the micro Kjeldahl method, lipid by ether extraction using a soxtec system, ash by combustion at 550°C for 12 hours, and energy by micro bomb calorimeter (AOAC, 1984).

RESULTS AND DISCUSSION

Table 1 showed the average initial and final weights of experimental frys during non feeding period (NFP) and feeding period (FP). After the beginning of experiment all the frys were deprived of feeding (-15.7 %). At the second week of feed deprivation there was no weight loss as they maintain themselves in this circumstance. It was observed that when feeding start there was still significant weight loss (-18.7 %) exhibited by the frys. There was an unusual result obtained during second cycle of feed deprivation as they gained weight upto 11.3% followed by weight loss -7.5% and –1.3% during next two successive weeks when feed was provided.

Table 1a. Formulation and proximate composition of the experimental feed.

Formulation (% wet weight)	
Fish meal	24.85
Wheat flour	35.81
Soybean meal	28.71
Fish meal	1.9
Vitamin premix	6.15
Mineral premix	2.58
Proximate composition*(% or K.cal /100g dry matter ;mean±SE; N = 5)*	
Crude protein	31.2±0.1
Crude lipid	3.2±0.2
Ash	16.2±0.2
Energy	15.6±0.2

Table 1b. Body weights at different times of the experiment in relation to cycles of deprivation.

Weeks	**Phases**	**Average initial weight (g)**	**Average final weight (g)**	**% weight loss(-) / % weight gain(+)**
1	NFP	2.669±1.713	2.512±1.681	15.7(-)
2	NFP	2.512±1.681	2.512±1.681	0.0
3	FP	2.512±1.681	2.325±1.584	18.7(-)
4	NFP	2.325±1.584	2.438±1.625	11.3(+)
5	FP	2.438±1.625	2.363±1.628	7.5(-)
6	FP	2.363±1.628	2.350±1.628	1.3(-)
7	FP	2.5354±1.628	2.881±1.822	52.7(+)
8	FP	2.881±1.822	3.55±1.620	66.9(+)

The all frys rapidly gained weight as they were obtained regular feed for next two weeks i.e. 52.7% and 66.9% respectively. Table 2 further clarifies the results under non-feeding period and feeding period. Specific growth rate (SGR) and average weight loss (ADL) was –2.24 and –0.022 in first cycle of feed deprivation and it was gradually improved from 0.0 to 1.614 and 0.016 in next cycle of deprivation. (Table 2; **Fig.12**) On the other hand i.e. in feeding phase the frys initially exhibited some compensation from weight loss to weight gain in 3rd and 6th weeks. When the regular feeding started from 6th to 8th weeks, the frys drastically gained weight. The values of SGR and ADG/ADL were significantly improved from –1.071, -0.0107 to 9.557, 0.0955. At the end of experiment, body concentration of moisture, protein, lipid, and ash were estimated in percentages while the energy concentration was calculated in k.cal/100g of body weight. The moisture, protein, lipids and ash were within the range of (mean±SE) 74.4±0.5 to 80.0±0.6; 9.5±0.4 to 14.9±0.3; 0.6±0.1 to 4.85±0.09 and 4.0±0.2 to 4.7±0.0 respectively. The energy concentration was 2.1±0.1 to 5.4±0.1. (Table 4; **Fig.3**)

Table 2. % weight loss/gain, specific growth rate and average daily weight loss (ADL) / gain (ADG) in duration of deprivation.

Duration of deprivation (Weeks)	% weight loss (-) /gain(+)	SGR	ADL / ADG
1	15.7(-)	2.24(-)	0.22(-)
2	0.0	0.0	0.0
4	11.3(+)	1.614(+)	0.016(+)

Table 3: % weight loss/gain, specific growth rate and average daily weight loss (ADL) / gain (ADG) in duration of feeding.

Duration of feeding (Weeks)	% weight loss (-) /gain(+)	SGR	ADL / ADG
3	18.7(-)	2.67(-)	0.026 (-)
5	7.5 (-)	1.071 (-)	0.010 (-)
6	1.3 (-)	0.185 (-)	0.001 (-)
7	52.7 (+)	7.52 (+)	0.075 (+)
8	66.9 (+)	9.55 (+)	0.095 (+)

Table 4. Body composition and energy concentration of *Oreochromis niloticus* at different times of experiment in relation to cycle of deprivation.

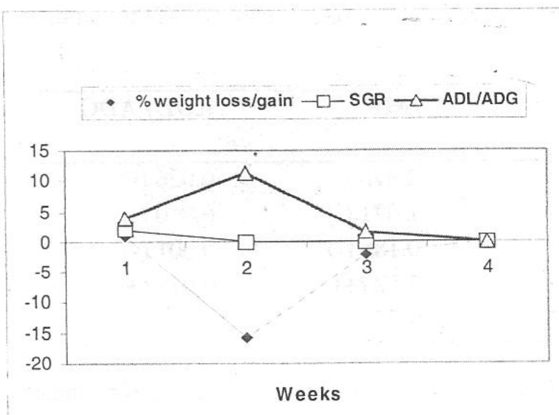
Weeks	Treatment condition	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Energy (K.cal/100g)
Initial		76.5±0.2	14.4±0.1	2.7±0.1	4.49±0.07	4.69±0.12
1	NFP	76.9±0.3	14.8±0.4	4.3±0.4	4.2±0.2	5.0±0.1
2	NFP	77.7±0.4	13.7±0.3	3.7±0.2	4.0±0.2	4.5±0.1
3	FP	80.3±0.4	12.6±0.5	1.6±0.3	4.7±0.0	3.4±0.1
4	NFP	84.0±0.6	9.5±0.4	0.6±0.1	n.a*	2.1±0.1
5	FP	74.4±0.5	14.9±0.3	5.1±0.3	4.4±0.1	5.4±0.1
6	FP	76.05±0.12	14.14±0.14	4.85±0.09	4.06±0.07	4.97±0.09
7	FP	75.93±0.30	14.39±0.11	4.25±0.30	4.27±0.10	4.86±0.11
8	FP	76.11±0.12	13.84±0.11	4.37±0.12	4.19±0.10	4.86±0.11

*Data not available because of insufficient samples.

DISCUSSION

There was no mortality during the experiment. The deprived fish did not show any marked behavioral change except that they became emaciated. The loss in body weight indicate that during non-feeding phase nitrogenous compounds may get partially converted to collagen to strengthen the skin envelop so as to prevent the rapid removal of lipid as was suggested by Hughes (1963). Earlier, Love (1958) reported that water tends to replace endogenous protein in deprived cod before lipid reserves get utilized. These may explain the observed phenomenon in the present case as well. After 2 week of regular non-feeding periods, body weights of fish were significantly lower followed by one week of feeding period. Some compensation was observed when regular feeding started upto end

(8th week). Russell and Wootten (1992) reported the same results as they worked on 1-2g minnows (*Phoxinus phoxinus*) for 3 weeks of refeeding after 16 days of deprivation. Dobson and Holmes (1984); Quinton and Black (1990) suggested that 16-120 rainbow trout show complete compensation after 3 weeks of deprivation. Food restricted fish are considered to show partial compensation if their growth rates upon refeeding are higher than those of the controls but final body weights at the end of the compensatory period are still lower than the fully feed controls (Weatherley and Gill, 1981, Miglavs and Jobling, 1989). As body weigh of food- restricted fish is usually smaller than that of the controls at the start of the refeeding period, higher growth rates would be expected among restricted fish between of the body size dependency of growth rate (Jobling, 1983) thus, care must be taken in interpreting the data on partial compensatory growth .In the present study, feed intake and growth rate data were adjusted for size effects and the analysis revealed that there was a partial compensatory response in fish deprived for 3 weeks. There was also a tendency for both feed intake and growth rate during refeeding to increase with the length of deprivation. In three cyprinids, growth rates during refeeding increased in proportion to the length of starvation (Wieser *et al.*, 1992). In minows, compensatory growth was detected in fish that were starved for 16 days, but not in fish that were starved for 4 days (Russel and Wootten, 1992). Thus, the magnitude of compensatory growth tends to be dependent on the severity of under nutrition.



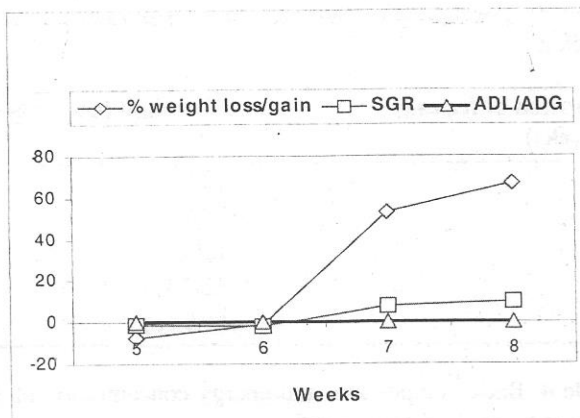


Fig.1. Growth performance of *Oreochromis niloticus* in duration of deprivation; Fig.2. Growth performance of *Oreochromis niloticus* in duration of feeding.

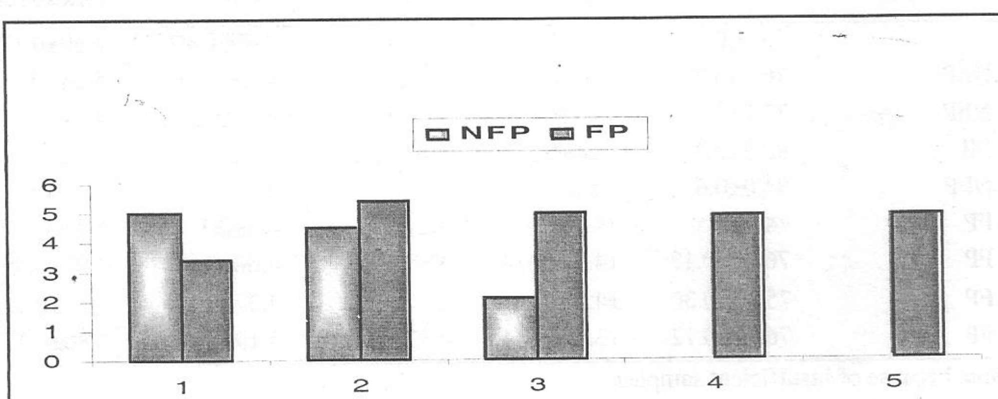


Fig.3. Energy concentration in non-feeding period (NFP) and feeding period (FP) at different time interval.

Hyperphagia may be the major contributor to the high growth rates during compensatory growth (Miglavs and Jobling, 1989; Russel and Wootton, 1992; Jobling and Koskela, 1996; Jobling *et al.*, 1994), and improved feed efficiency has been reported for some fishes compensatory growth (Bilton and Robins, 1973; Dobson and Holmes, 1984; Russell and Wootton, 1992; Jobling *et al.*, 1994; Qian *et al.*, 2000). In the present study, hyperphagia was observed, but without any improvement in feed efficiency relative to the controls.

Jobling *et al.* (1994) suggested that the composition of accretion may differ between animals displaying growth and normal body growth, and that animals with preferential accretion of lean body mass would be expected to display better feed efficiency than those depositing greater amounts of body fat. The argument was supporting by findings in gibel carp, *Carassius auratus* gibelio, which showed improved feed efficiency and protein growth during compensatory growth (Qian *et al.*, 2000).

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