Short and Long feed Starvation-Refeeding Regime in Polyculture Ponds of *Oreochromisniloticus* and *Mugilcephalus*

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Abstract: The current study was conducted in a private fish farm at Dakahlia governorate, in polyculture earthen pond containing *Oreochromisniloticus* and *Mugilcephalus*. The aim of the study is to (i) access the impact of different periods of starvation followed by refeeding regimes in polyculture ponds containing *Oreochromisniloticus* and *Mugilcephalus*, and to (ii) evaluate the effect of starvation on fish growth performance and hematological parameters; in a trial to reduce the economic costs needed for the fish farm. Starvation of fish was performed for different periods; 7, 14, 21 days followed by refeeding on commercial fish ration (25%protein) at least 4 weeks. Fish growth parameters and hematological investigations were recorded for the starved fish and control group (kept without starvation) along the period of experiment. It was observed that starvation of fish for up to 14 day (Group 2) followed by refeeding did not have a significant negative effect on both growth and hematological parameters. Growth parameters of fish starved for 14 days were the best because they exceeded control levels. This could be of an economic profit because the final outcome of both starvation- refeeding regime and feeding without food restrictions will be equal. That is why the total expenses of feedstuff costs of the daily fish feeding will be reduced. [Marwa F. Abd El-Kader, Eman M. M. Moustafa and Tarek M. Mousa-Balabel**Short and Long feed Starvation-Refeeding Regime in Polyculture Ponds of *Oreochromisniloticus* and *MugilcephalusNat Sci*2017;15(8):203-208].ISSN 1545-0740 (print); ISSN 2375-7167 (online).http://www.sciencepub.net/nature.31. doi:10.7537/marsnsj150817.31.

Keywords:Hematology, *Mugilcephalus*, *Oreochromisniloticus,* Polyculture, Refeeding, Starvtion.

1. Introduction

Fasting or food deprivation is a normal phenomenon that can be experienced by many fish species in natural habitat and in culture conditions (Barcellose*et al.,* 2010)

Starvation is known to determine significant changes in fish physiology, especially in their pattern of metabolic enzymes and proteins (Navarro and Gutierrez, 1995; Hung *et al.,* 1997 and Shimeno*et al.,* 1997).

Feed restriction or deprivation for short periods may also be adopted by fish farmers as a managemental strategy to reduce mortality rate due to disease outbreaks (Shoemaker *et al.,* 2003) or to solve water quality problems and reduce handling stress (Davis and Gaylord, 2011).

Food is generally the highest variable costs at aquaculture facilities. Knowing the nutrient requirements of fish and applying appropriate feeding strategies can reduce the waste and increase profits (Ali *et al.,* 2016).

Optimizing the food is a strategy to decrease food costs, which is a vital step in the management of intensive fish culture Lovell, 1998. It is necessary to determine the fish response to different feeding regimes to detect the optimal duration of food deprivation (Najafi*et al.,* 2015).

The aim of the current study was to (i) suggest the suitable period of starvation followed by refeeding regimes in polyculture ponds containing *Oreochromisniloticus* and *Mugilcephalus*, and to (ii) evaluate the effect of starvation on fish growth performance and hematological parameters; in a trial to reduce the economic costs needed for the fish farm.

2. Materials and Methods

The current study was carried out in a private fish farm at Belkas, Dakahlia Governorate, during the year 2016 from April to October.

Experimental design:

The experiment was performed in eight earthen ponds; (4200 m^2 each). The mean water depth in all ponds was about 125 cm. Each pond has an inlet and outlet water gates through which water level is controlled. The water filling and draining of the experimental ponds is maintained by water machine and water pipes. Each pond contains 9000 *Oreochromisniloticus* and 4000 *Mugilcephalus*.

The ponds were divided into four equal groups; (2 ponds/each). The fishes in groups 1, 2, and 3 were

starved for 7, 14, and 21 days, respectively. Subsequently, they were refed after the starvation period for four weeks using commercial fish ration 25% protein (manufactured by ALEKHWA feed factory; a local Egyptian fish feed factory), followed by a same starvation period and refeeding regime in a successive manner along the period of the experiment (7 months). Group 4 was kept as a control (without starvation).

Fishes inside the polyculture earthen ponds were checked 4 times/each starvation-refeeding regime (before starvation- after first starvation- after last starvation & at the end of 7 months).

Summer mortality rates during July was recorded, fish growth measurements and hematological samples were investigated.

Determination of fish growth parameters:

The fish were randomly weighted (100 fish/each spp/ group) using an electronic balance

Total weight gain (TWG) (g) = final body weight (g)– initial body weight (g)

Specific growth rate (SGR) = [(Ln W2 – Ln W1)/ T] x 100

Where: Ln = the natural log, W2 = final weight at certain period (g),

W1 = initial weight in the same period (g) and T = experimental period (in days).

Hematological investigation:

The erythrocytes and leukocytes count were determined according to the method described by Stoskopf (1993), Hemoglobin concentration was determined using the cyanomet-hemoglobin method with Drabkin's solution according to Stoskopf (1993) and Packed cell volume determination according to Dacie and Lewis (1991).

Lysozyme concentrations assays:

The lysozyme activity of blood sera for diseased fish were assayed according to the method described by Demers and Bayne (1997), based on the ability of lysozyme to lyses Gram positive lysozyme sensitive bacterium; *Micrococcus lysodeikticus*.

Blood serum biochemical analysis:

Serum total protein was determined according to Doymas*et al.,* (1981) at the wave length 540 nm, Serum albumin was estimated colorimetricly at wave length 550 nm according to Dumas and Biggs (1972). Globulins content was calculated mathematicaly. Activities of aspartate amninotransferase (AST) and alanine aminotransferase (ALT) were determined calorimetrically at the wave length 540 nm, according to Reitman and Frankel (1957).Glucose level (mg/100 ml) was determined according to Trinder (1969) using glucose enzymatic PAP kits obtained from Bio-Merieux (France).

Statistical analysis:

Statistical analysis was performed using SPSS software version 16.0, Chicago, IL. Significant difference was determined at probability level of ($P<$ 0.05).

3. Results and Discussion

Fish growth parameters and hematological investigation results are presented in Tables (1-3).

Approximately, no mortality was recorded during the experimental period, neither during the restricted feeding period nor during the satiation feeding period. An almost similar study on *Mugilcephalus* (Akbary&Jahanbakhshi, 2016) and *C. carpio* (Friedrich &Stepanoswska, 2001) for eight weeks starvation period confirms the result.

Starvation for seven days(Group 1) in the earthen ponds did not change either the growth nor the hematological parameters as shown in tables (2-4). This might be attributed to the natural feed of phytoplanketon and/or zooplanketon in the pond.

First starvation for 14 days (Group 2) resulted in (i) decreased level of RBCs, Hb and PCV. (ii) WBCs count and lysozyme were not affected. (iii) ALT and AST levels were slightly increased. (iv) Decreased level of total protein, albumin, globulin and glucose. (v) Slightly decreased body weight. However, after application of alternative starvation and refeeding regime for this group resulted in increased the level of all parameters towards the control level; beneficial effect of exceeded growth performance, Increased level of RBCs, Hb and PCV, increased the level of the total protein, albumin, globulin and glucose, increased level of WBCs count at the end of the experiment, but, lysozyme, ALT and AST levels returned to the normal control levels.

First starvation for 21 days (Group 3) resulted in (i) decreased level of RBCs, Hb and PCV. (ii) WBCs count was not affected. (iii) Lysozyme, ALT and AST levels were increased. (iv) Decreased level of the total protein, albumin, globulin and glucose. (v) Decreased body weight. The decrease in body weight was relatively restored after the alternative starvation-refeeding regime toward the control level but, group 2 gave the best results out of all groups.

Mortality rates of *Oreochromisniloticus* were detected to be 10, 4, 7 and 10% in Groups 1, 2, 3 and control group, respectively; while in *Mugilcephalus*, mortality rates were 3, 2, 5 and 4% in Groups 1, 2, 3 and control group, respectively. This means that the starvation may increase the resistance to disease outbreaks (which occurred in July of each year) for the fish species used in the current study,

The fish after first starvation was characterized by decreased body weight due to decreased growth rate resulting from starvation, but, the final body weight and growth rate were exceeded the control

level.This might be attributed to a lower metabolic rate during starvation and coping with in different ways to food deprivation (Zhu *et al*., 2001; Wu *et al*., 2002; Ali *etal*., 2003 and Roldogan*et al*., 2006).

The increase of total protein level after starvation-refeeding regime suggesting that periods of starvation in different groups could not induce any proteolytic activity on body protein and only the blood protein was used in gluconeogenesis process. The result is in accordance with Friedrich &Stepanoswska (2001) and Akbary&Jahanbakhshi (2016).

Table1: Effect of starvation-refeeding regime on haematological parameters in *Oreochromis niloticus* and *Mugil cephalus*

Sampling Day	treat	*Oreochromis niloticus*							*Mugil cephalus*						
		RBCs ($\times 10^{6/}$mm^3)	Hb (g/100ml)	Pcv (%)	MCV (μm$^{3/cell}$)	MCH (pg/cell)	MCHC %	WBCs ($\times 10^{3/}$mm^3)	RBCs ($\times 10^{6/}$mm^3)	Hb (g/100ml)	Pcv (%)	MCV (μm$^{3/cell}$)	MCH (pg/cell)	MCHC %	WBCs ($\times 10^{3/}$mm^3)
zero	G1	2.18 ±0.03[b]	7.10 ±0.04[ab]	21.00 ±0.02	96.33 ±0.1	32.59 ±0.03	33.83 ±0.01[a]	40.28 ±0.03[a]	3.37 ±0.08[c]	11.49 ±0.14	33.05 ±0.06	98.08 ±0.07[a]	34.10 ±0.05[a]	34.77 ±0.03	33.77 ±0.03[d]
	G2	2.20 ±0.1[a]	7.20 ±0.01[a]	21.20 ±0.05	96.14 ±0.04	32.65 ±0.02	33.96 ±0.07[a]	39.79 ±0.04[d]	3.41 ±0.05[a]	11.50 ±0.08	33.00 ±0.1	96.77 ±0.05[c]	33.72 ±0.02[b]	34.85 ±0.11	34.34 ±0.1[a]
	G3	2.19 ±0.04[b]	7.05 ±0.1[b]	21.15 ±0.03	96.57 ±0.1	32.19 ±0.02	33.33 ±0.11[b]	40.05 ±0.05[c]	3.39 ±0.05[b]	11.49 ±0.05	33.04 ±0.05	97.32 ±0.01[b]	33.85 ±0.01[b]	34.79 ±0.05	34.29 ±0.03[b]
	G4	2.18± 0.01[b]	7.05 ±0.01[b]	21.25 ±0.05	97.25 ±0.03	32.26 ±0.1	33.17 ±0.01[b]	40.13 ±0.06[b]	3.40 ±0.12[ab]	11.50 ±0.07	33.00 ±0.01	96.91 ±0.03[bc]	33.77 ±0.01[b]	34.85 ±0.05	34.21 ±0.04[c]
After 1ststarvation	G1	2.25 ±0.04[b]	7.20 ±0.01[b]	21.00 ±0.12[b]	93.33 ±0.21[c]	32.00 ±0.04[ab]	34.29 ±0.05[a]	40.77 ±0.07[a]	3.57 ±0.01[a]	11.74 ±0.05[a]	33.30 ±0.02[a]	93.28 ±0.06[b]	32.89 ±0.1[b]	35.26 ±0.04[b]	34.97 ±0.05[a]
	G2	1.99 ±0.12[c]	6.40 ±0.01[c]	19.10 ±0.05[c]	96.00 ±0.2[a]	32.18 ±0.08[a]	33.525 ±0.1[c]	40.21 ±0.05[c]	2.72 ±0.02[c]	8.05 ±0.04[b]	23.00 ±0.04[c]	84.40 ±0.08[c]	29.54 ±0.05[c]	35.00 ±0.01[b]	34.89 ±0.05[b]
	G3	1.97 ±0.014[d]	6.30 ±0.05[d]	19.00 ±0.17[c]	96.20 ±0.07[a]	31.90 ±0.05[b]	33.16 ±0.11[d]	39.91 ±0.11[d]	2.61 ±0.02[d]	7.90 ±0.01[c]	22.02 ±0.05[d]	84.36 ±0.01[c]	30.27 ±0.04[d]	35.87 ±0.01[a]	34.12 ±0.05[d]
	G4	2.27 ±0.03[a]	7.30 ±0.07[a]	21.40 ±0.11[a]	94.06 ±0.19[b]	32.09 ±0.1[ab]	34.11 ±0.07[b]	40.39 ±0.05[b]	3.51 ±0.01[b]	11.72 ±0.11[a]	33.20 ±0.07[b]	94.45 ±0.04[a]	33.35 ±0.13[a]	35.31 ±0.01[b]	34.81 ±0.01[c]
After 2ndstarvation	G1	2.52 ±0.01[b]	7.70 ±0.01[b]	21.60 ±0.01[b]	85.56 ±0.01[b]	30.49 ±0.1[b]	35.64 ±0.11	40.97 ±0.1[c]	3.59 ±0.08[c]	12.00 ±0.11[b]	34.06 ±0.11[b]	94.87 ±0.08[b]	33.43 ±0.03[b]	35.23 ±0.11	35.22 ±0.04[c]
	G2	2.91 ±0.01[a]	10.05 ±0.01[a]	28.50 ±0.05[a]	97.94 ±0.05[a]	34.53 ±0.03[a]	35.27 ±0.07	47.72 ±0.1[a]	3.91 ±0.01[a]	13.00 ±0.03[a]	37.00 ±0.06[a]	94.51 ±0.12[bc]	33.21 ±0.19[b]	35.15 ±0.11	40.13 ±0.1[a]
	G3	2.54 ±0.03[d]	7.70 ±0.01[b]	21.70 ±0.02[b]	85.45 ±0.13[b]	30.31 ±0.01[b]	35.47 ±0.1	45.50 ±0.11[b]	3.50 ±0.01[d]	12.00 ±0.02[b]	34.00 ±0.07[b]	97.14 ±0.15[a]	34.29 ±0.21[a]	35.29 ±0.1	36.25 ±0.05[b]
	G4	2.51 ±0.02[c]	7.60 ±0.02[b]	21.50 ±0.01[b]	85.66 ±0.05[b]	30.30 ±0.03[b]	35.37 ±0.14	40.81 ±0.05[d]	3.61 ±0.1[b]	12.05 ±0.11[b]	34.00 ±0.15[b]	94.05 ±0.11[c]	33.33 ±0.09[b]	35.44 ±0.21	35.05 ±0.05[d]
End of experiment	G1	2.69 ±0.04[b]	8.05 ±0.11[b]	23.00 ±0.21[b]	85.34 ±0.03[b]	29.87 ±0.17[b]	35.00± 0.05[b]	41.29 ±0.14[c]	3.79 ±0.01[b]	12.50 ±0.05[b]	37.00 ±0.12[a]	97.63 ±0.08[a]	32.98 ±0.07[b]	33.78 ±0.01[c]	34.98 ±0.1[d]
	G2	2.98 ±0.01[a]	10.00 ±0.12[a]	28.05 ±0.21[a]	94.13 ±0.02[a]	33.57 ±0.09[a]	35.66 ±0.11[a]	47.82 ±0.05[a]	3.97 ±0.05[a]	13.00 ±0.03[a]	37.05 ±0.05[a]	93.20 ±0.08[c]	32.71 ±0.1[c]	35.10 ±0.05[b]	40.19 ±0.04[a]
	G3	2.65 ±0.01[d]	7.90 ±0.05[c]	22.00 ±0.05[c]	82.86 ±0.47[c]	29.75 ±0.02[b]	35.91 ±0.12[a]	41.33 ±0.22[b]	3.71 ±0.03[c]	12.50 ±0.04[b]	35.00 ±0.05[b]	94.34 ±0.19[b]	33.69 ±0.21[a]	35.71 ±0.01[a]	35.41 ±0.02[b]
	G4	2.64 ±0.01[c]	7.90 ±0.05[c]	22.00 ±0.03[c]	83.33 ±0.04[c]	29.92 ±0.16[b]	35.91 ±0.08[a]	41.33 ±0.08[b]	3.71 ±0.01[c]	12.50 ±0.01[b]	35.05 ±0.14[b]	94.34 ±0.19[b]	33.66 ±0.05[a]	35.67 ±0.07[a]	35.23 ±0.05[c]

For each day of sampling: Treatments mean within the same column of different litters are significantly different at ($P<0.05$)

Table 2: Effect of starvation-refeeding regime on serum biochemical analysis in *Oreochromis niloticus* and *Mugil cephalus*

sampling Day	treat	*Oreochromis niloticus* ALT (U/l)	AST (U/l)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	glucose (mg/dl)	lysozyme (u/ml)	*Mugilcephalus* ALT (U/l)	AST (U/l)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	glucose (mg/dl)	lysozyme (u/ml)
Zero day	G1	6.23 ±0.03[a]	70.66 ±0.04[d]	5.21 ±0.09[b]	3.20 ±0.02[a]	2.00 ±0.01[c]	27.81 ±0.1[a]	30.22 ±0.31[a]	13.97 ±0.04[b]	98.70 ±0.07[b]	5.68 ±0.01[c]	3.40 ±0.01[a]	2.28 ±0.01[c]	48.91 ±0.11[d]	40.97 ±0.15[c]
	G2	6.22 ±0.02[ab]	71.40 ±0.01[b]	5.20 ±0.01[b]	3.20 ±0.01[a]	2.00 ±0.04[c]	27.24 ±0.09[b]	30.05 ±0.31[b]	13.98 ±0.05[ab]	98.65 ±0.05[b]	5.70 ±0.02[ab]	3.30 ±0.01[b]	2.40 ±0.01[a]	49.61 ±0.09[a]	41.29 ±0.09[a]
	G3	6.19 ±0.01[c]	71.91 ±0.1[a]	5.20 ±0.05[b]	3.10 ±0.01[b]	2.10 ±0.03[a]	27.18 ±0.08[d]	30.31 ±0.27[a]	13.98 ±0.05[ab]	99.05 ±0.05[a]	5.71 ±0.05[a]	3.40 ±0.01[a]	2.31 ±0.02[b]	49.25 ±0.09[b]	41.09 ±0.08[b]
	G4	6.20 ±0.02[bc]	71.39 ±0.05[c]	5.23 ±0.08[a]	3.20 ±0.01[a]	2.03 ±0.02[b]	27.20 ±0.11[c]	30.29 ±0.4[a]	13.99 ±0.05[a]	99.15 ±0.09[a]	5.69 ±0.01[b]	3.40 ±0.01[a]	2.29 ±0.05[c]	49.12 ±0.21[c]	41.15 ±0.14[b]
After 1st starvation	G1	6.22 ±0.01[c]	70.49 ±0.01[c]	5.31 ±0.01[b]	3.20 ±0.05[b]	2.11 ±0.03[a]	27.99 ±0.11[a]	30.01 ±0.11[c]	14.05 ±0.04[c]	98.97 ±0.01[c]	5.77 ±0.01[b]	3.42 ±0.03[a]	2.35 ±0.05[a]	50.32 ±0.11[a]	40.88 ±0.23[d]
	G2	6.81 ±0.02[b]	73.10 ±0.09[b]	4.37 ±0.04[c]	2.89 ±0.01[c]	1.48 ±0.03[c]	20.25 ±0.18[c]	30.11 ±0.12[b]	14.99 ±0.03[b]	100 ±0.31[b]	4.61 ±0.01[c]	2.88 ±0.01[b]	1.73 ±0.05[b]	40.11 ±0.2[c]	40.89 ±0.11[c]
	G3	7.42 ±0.01[a]	79.91 ±0.21[a]	4.11 ±0.01[d]	2.77 ±0.01[d]	1.34 ±0.01[d]	18.06 ±0.11[d]	39.71 ±0.01[a]	15.27 ±0.03[a]	109.24 ±0.031[a]	4.21 ±0.05[d]	2.71 ±0.01[c]	1.50 ±0.01[c]	38.01 ±0.13[d]	49.18 ±0.17[a]
	G4	6.18 ±0.01[d]	70.33 ±0.03[d]	5.37 ±0.1[a]	3.30 ±0.02[a]	2.06 ±0.03[b]	27.91 ±0.1[b]	29.75 ±0.21[b]	13.98 ±0.08[d]	99.20 ±0.01[b]	5.78 ±0.05[a]	3.44 ±0.02[a]	2.34 ±0.01[a]	50.18 ±0.11[b]	40.91 ±0.21[b]
After 2nd starvation	G1	6.17 ±0.01[c]	70.11 ±0.04[d]	5.61 ±0.01[b]	3.45 ±0.01[b]	2.16 ±0.01[b]	28.29 ±0.11[c]	29.89 ±0.21[d]	13.90 ±0.09[b]	99.07 ±0.11[c]	5.83 ±0.01[b]	3.51 ±0.02[b]	2.31 ±0.05[b]	50.41 ±0.24[b]	40.81 ±0.05[c]
	G2	6.19 ±0.05[b]	70.17 ±0.01[c]	5.91 ±0.01[a]	3.56 ±0.01[a]	2.34 ±0.02[a]	36.02 ±0.21[a]	30.11 ±0.11[c]	13.80 ±0.02[d]	98.12 ±0.13[d]	6.24 ±0.01[a]	3.89 ±0.01[a]	2.35 ±0.02[a]	59.18 ±0.11[a]	40.79 ±0.07[d]
	G3	6.20 ±0.05[b]	70.44 ±0.01[b]	5.42 ±0.03[d]	3.30 ±0.05[d]	2.12 ±0.02[c]	28.25 ±0.09[d]	34.25 ±0.017[a]	14.21 ±0.03[a]	99.41 ±0.11[a]	5.71 ±0.02[d]	3.40 ±0.01[d]	2.31 ±0.02[b]	50.40 ±0.13[b]	43.11 ±0.01[a]
	G4	6.21 ±0.04[a]	70.78 ±0.02[a]	5.54 ±0.01[c]	3.40 ±0.01[c]	2.14 ±0.01[bc]	28.34 ±0.09[b]	30.22 ±0.11[b]	13.81 ±0.05[c]	99.23 ±0.21[b]	5.81 ±0.01[c]	3.50 ±0.01[c]	2.31 ±0.02[b]	50.37 ±0.21[c]	40.89 ±0.09[b]
End of experiment	G1	6.29 ±0.01[b]	70.51 ±0.05[a]	5.94 ±0.01[b]	3.52 ±0.01[b]	2.41 ±0.01[b]	30.02 ±0.09[b]	30.61 ±0.02[a]	13.61 ±0.01[c]	98.27 ±0.22[b]	5.89 ±0.01[b]	3.53 ±0.01[b]	2.36 ±0.02[b]	50.44 ±0.11[c]	40.76 ±0.09[b]
	G2	6.22 ±0.01[c]	70.39 ±0.05[c]	6.32 ±0.02[a]	3.77 ±0.01[a]	2.55 ±0.01[a]	38.14 ±0.05[a]	30.57 ±0.12[b]	13.72 ±0.05[b]	98.20 ±0.14[c]	6.41 ±0.01[a]	3.91 ±0.01[a]	2.50 ±0.01[a]	59.99 ±0.21[a]	40.34 ±0.09[c]
	G3	6.24 ±0.01[c]	70.45 ±0.05[b]	5.91 ±0.01[c]	3.51 ±0.03[bc]	2.39 ±0.01[bc]	29.93 ±0.05[c]	30.59 ±0.11[ab]	13.71 ±0.05[b]	98.29 ±0.18[a]	5.84 ±0.03[c]	3.50 ±0.01[c]	2.33 ±0.01[c]	50.42 ±0.11[d]	40.80 ±0.05[a]
	G4	6.32 ±0.07[a]	70.43 ±0.04[b]	5.90 ±0.04[c]	3.51 ±0.05[c]	2.39 ±0.03[c]	29.89 ±0.09[d]	30.55 ±0.18[c]	13.75 ±0.01[a]	98.19 ±0.21[d]	5.84 ±0.01[d]	3.50 ±0.02[c]	2.34 ±0.01[c]	50.49 ±0.09[b]	40.79 ±0.11[a]

For each day of sampling: Treatments mean within the same column of different litters are significantly different at ($P<0.05$)

As a result of the present study, serum ALT and AST levels increased during starvation periods. This result is in accordance with Park *et al*., (2012), but in contrast to Akbary&Jahanbakhshi (2016). This might suggest that environmental and physiological conditions can affect ALT and AST levels in response to starvation period. In the current study, Serum glucose level was decreased in starved groups for 14 and 21 days; the result is in accordance with Cosras*et al.* (2011) and Caruso *et al.* (2012), respectively.

Haematological parameters were considered as one of the vital physiological indicators to assess starvation stress effects in fish. In the current study,fasting caused no significant changes in the number of WBCs ($P> 0.05$), However, the number of these cells after refeeding period significantly increased ($P< 0.05$). These results are similar to that recorded by Najafi*et al.*(2015).

Starvation is reported to trigger the innate immunity. It was recorded that starvation for 31 days in European eel lead to significant decrease of serum lysozyme activity (Caruso *et al*., 2010) and significant increase of serum lysozyme activity in Jeuvenile Chinese Sturgeon Feng *etal*.(2011) when the starvation period was increased. In the current study, serum lysozyme activity was increased when the starvation time is increased in group 3. This suggests that the starvation is not a stressor on non-specific immunity system. This result is similar to Feng *et al*. (2011).

Table 3: Effect of starvation-refeeding regime on fish growth parameters in *Oreochromis niloticus* and *Mugil cephalus*

Treat	Oreochromisniloticus				Mugilcephalus			
	Initial Weight (g)	Final Weight (g)	Total Weight Gain (g)	SGR (%/day)	Initial Weight (g)	Final Weight (g)	Total Weight Gain (g)	SGR (%/day)
G1	29.15±0.02[b]	337.50±0.21[b]	308.35±0.1[b]	0.506±0.01[b]	30.70±0.04[a]	390.50±0.09[b]	359.80±0.21[b]	0.526±0.01[b]
G2	28.48±0.03[c]	380.50±0.05[a]	352.02±0.11[a]	0.536±0.01[a]	29.80±0.01[d]	450.50±0.31[a]	420.70±0.09[a]	0.561±0.02[a]
G3	29.95±0.01[a]	295.50±0.43[d]	265.55±0.24[d]	0.473±0.04[c]	30.60±0.05[b]	370.50±0.11[d]	339.90±0.11[c]	0.515±0.01[c]
G4	28.40±0.01[c]	320.50±0.12[c]	292.10±0.11[c]	0.501±0.01[b]	30.40±0.01[c]	385.50±0.24[c]	355.10±0.11[c]	0.525±0.01[b]

Treatments mean within the same column of different litters are significantly different at ($P< 0.05$).

Conclusion

With regard to the obtained results of starvation for 7, 14, and 21 days and subsequent refeeding regime for at least four weeks by a commercial ration, has no significant negative effects on most growth rate and physiological parameters. Therefore, farm owners of commercial fish farms could restrict food delivery to fish for a period not exceeding 14 days followed by refeeding regime. It could be evident that an economic benefit will be achieved, because the final outcome of both starvation-refeeding regime and feeding without food restrictions; will be equal. Besides, the general expenses of especially feedstuff costs dedicated to the daily feeding of the fish would be reduced.

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8/12/2017