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Effect of Dietary Protein and Over-Wintering Regimes on Survival and Growth Performance of Nile Tilapia, *Oreochromis niloticus*

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Abstract: This study was carried out to investigate the effect of dietary protein levels and covering area by polyethylene sheet for ponds during over-wintering of mono sex Nile tilapia, *Oreochromis niloticus* (1±0.02g). The experiment was designed to test two dietary protein levels (25 or 32%) within each level two covering area with polyethylene sheets (75% or 100% pond of ponds) were also tested. The experimental period was divided into two periods, the first one before over-wintering (1st October to 31st November). The second period (during the over-wintering) from 1st December until 15th April. Fish reared during the two periods in concrete ponds. The treatments applied were T1 (25% protein+75% covering area), T2 (25% protein+100% covering area), T3 (32% protein+75% covering area) and T4 (32% protein+100% covering area). Results obtained indicated that T4 showed the best growth performance and biochemical parameters and the highest protein, ash, fat content of fish bodies, while T1 recorded the highest liver function. It can be concluded that feeding *O. niloticus* fry on diet containing 32% protein, before and during the winter season, taking into account the coverage of concrete ponds by polyethylene cover during the winter months led to an increase in survival rate.

Key words: Protein Level · Over-Wintering · Oreochromis Niloticus

INTRODUCTION

In fish, as in other ectothermic animals, ambient temperatures influence lipid accumulation rates before winter [1] and depletion rates during winter [2] since enzymatic processes and basal metabolic rates generally increase with temperature. Temperature will, thus, affect individual risk of starvation [2, 3] and thereby, potentially, population dynamics. Many energetic models assume that feed consumption will drop to near zero at low temperatures leading to obligate starvation [4, 5]. However, this view has been seriously challenged by numerous studies [6, 7]. Although not yet properly tested, it appears reasonable to assume that the utilization rate of lipid stores is affected not only by temperature, but also by food availability at very low temperatures. Research efforts that assess the response of juvenile fish to small low-temperature differences under different resource conditions are therefore much needed.

In Egypt, the majority of fish farmers do not feed fish during winter time where water temperature varies from 6-20°C. Although Egypt usually has a mild winter fish farmers claim that fish don't eat or grow under the prevalent climatic conditions of water however this has not been proved experimentally. Chervinski [8] reported that the activity and feeding tilapia become reduced below 20°C and feeding stops around 16°C. Dupree and Huner [9] reported that tilapia becomes lethargic and stops feeding when temperature falls below 15.5°C. Abdel-Ghany [10] reported that fish without feeding in winter lost significantly ($P<0.05$) body weight. Fish received feed at either 1 or 2% of body weight gained substantial weights. Fish producers addressing spring markets could increase weight gain and improve the FCR by adjusting over winter-feeding. Noor El Deen and Mona Zaki [11] indicated that, temperature ranged from 10-28°C on ponds and as revealed by field observations, most of fish farms in Egypt experienced a significant fish kill especially farms of earthen ponds or concrete ponds. The exception of this high mortality was in some farms that used house plastic to protect their fish against low temperature. In Egyptian fish farms, water temperature was 18-28°C that was suitable for fish growth. While during January, February and March temperature dropped

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to 10°C and lower, which is not only unsuitable to tilapia growth but also threatening tilapia survival. So, fish mortality started to be observed in most of the experimental tanks. In the tanks totally covered (100%) by plastic sheet, temperature was suitable for fish growth and survival. The present experiment aimed to study the effect of protein levels and covering area of rearing ponds during over-wintering period on survival rate the growth performance and proximate analysis of *O. niloticus* bodies.

MATERIALS AND METHODS

The present study was carried out in a private farm at Tollumbat No. 7 in Riyad City, Kafr El-Sheikh governorate, Egypt. Eight concrete ponds (2.7×22 m) with a water depth of 1.35m were stocked with mono sex *O. niloticus* fry (1±0.02g) at a density of 150 fry/M^3 to represent 4 treatments (two protein levels, 25, 32% within each protein level, two ponds covering area 75 or 100%. The experimental period expanded 50 weeks during the period from 1st October to 15th November.

During the first and the second month fish fed the experimental diets at a daily rate of 10% of body mass 6 days weekly. Experimental diets were offered in two equal parts daily at 9 am and 1 pm. The ponds were divided into two covering area by polyethylene sheet as 75 and 100% of pond area. During the over-wintering without feeding except the sun days, the daily feeding rate reduce to 2%. Feed quantity was adjusted according to average body weight of the sample in each pond. In order to determine the average weight of fish, biweekly samples were taken by seining where 30 fishe from each pond were collected, weighted and then returned again into the pond after individual measuring the weight and length.

Water Management: Water temperature, dissolved oxygen and pH were measured weekly at 6 a.m. and 12 p.m. using thermometer, dissolved oxygen meter (YSI model 57) and pH meter (Model Corning 345), respectively. Determinations of the other water quality parameters (Alkalinity and ammonia) were carried out every two weeks according to the methods of Boyd [12].

At the end of over-wintering period, six fish were taken randomly from each replicate (2 replicates for each treatments) for chemical analysis of blood glucose, serum cholesterol, triglycerides, total lipids, hemoglobine (Hb) and liver enzymes. Anothr, six fish were taken randomly from each pond for chemical analysis of the whole fish body. Fish and the experimental diet were analyzed according to the methods of AOAC [13].

Biochemical Parameters: Blood samples were taken from 3 fish for each replicate. After the end of the over-wintering directly, samples were sent to a laboratory of blood analysis to estimate traits under consideration.

Statistical Analysis: The statistical analysis of data collected was analyzed using one way analysis of variance for first and third periods but the second period using two way analysis of variance and carried out by applying the computer program [14]. Differences among means were tested for significance according to Duncan's multiple range tests [15].

RESULTS AND DISCUSSION

Biochemical Parameters: As shown in Table (1) the high dietary protein (32%) significantly increased blood glucose, cholesterol, triglycerides and total lipids compared with the low dietary protein content (25%). Also, the complete covering of ponds with plastic sheets significantly ($P<0.05$) increased these parameters. The interaction between dietary protein and covering area in the present study showed that, fish fed the high dietary protein (32%) in complete covering ponds (100%) showed the highest blood glucose, cholesterol, triglycerides and total lipids compared with the low dietary protein content (25%).

As shown in Table (1) the high dietary protein (32%) significantly increased hemoglobin while liver enzymes (AST and ALT) did not significantly affected compared to the low dietary protein content (25%). Also, the complete covering of the experimental ponds with plastic sheets significantly ($P<0.05$) increased hemoglobin and decreased AST while ALT but the differences were not significant. The interaction between dietary protein and covering area in the present study showed that, fish fed the high dietary protein (32%) in complete covering ponds (100%) showed the highest hemoglobin, compared with the low dietary protein content (25%).

Avnimelech *et al*. [17] reported that one of the most common blood variables consistently influenced by diet is the levels of hematocrite (Hct) and hemoglobine (Hb).

Analysis of variance showed that, blood glucose, serum cholesterol, serum triglycerides, serum total lipids, Hb and liver enzymes were significantly ($P<0.05$) affected by over-wintering and feeding regimes used in the present study. Chen *et al*. [18] studied the comparative blood chemistry and histopathology of tilapia infected with *Vibrio vulnificus* or *Streptococcus iniae* or exposed to carbon tetrachloride, gentamicin, or copper sulphate. He found that, haematological parameters are an important tool of diagnosis that reveals the state of health of fish.

Table 1: Effect of dietary protein and covering area of ponds on hematological parameters of *O. niloticus*

Treatments	No.	Glucose mg/dl	S. cholesterol mg/dl	Triglycerides mg/dl	Total lipids mg/dl
Protein level (P)					
P1 (25%)	12	56.00±1.26^{b}	83.78±1.56^{b}	200.95±3.72^{b}	540.14±7.12^{b}
P2 (32%)	12	65.50±1.26^{a}	94.50±1.56^{a}	237.82±3.72^{a}	618.67±7.12^{a}
Covering area (C)					
C1 (75%)	12	52.00±1.26^{b}	76.19±1.56^{b}	193.99±3.72^{b}	508.61±7.12^{b}
C2 (100%)	12	69.50±1.26^{a}	102.09±1.56^{a}	244.78±3.72^{a}	650.20±7.12^{a}
Interactions (P×C)					
T1 (P1×C1)	6	48.00±1.78^{c}	69.45±2.21^{c}	172.79±5.27^{c}	458.75±9.22^{c}
T2 (P1×C2)	6	64.00±1.78^{b}	98.12±2.21^{a}	229.12±5.27^{b}	621.53±9.22^{ab}
T3 (P2×C1)	6	56.00±1.78^{bc}	82.93±2.21^{b}	215.20±5.27^{b}	558.47±9.22^{b}
T4 (P2×C2)	6	75.00±1.78^{a}	106.07±2.21^{a}	260.44±5.27^{a}	678.86±9.22^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different ($P \leq 0.05$).

Table 2: Effect of dietary protein and covering area of ponds on blood components of *O. niloticus*

Treatments	No.	Hemoglobin (Hg)% g/dl	SGOT (AST) U/L	SGPT (ALT) U/L
Protein level				
P1 (25%)	12	6.75±0.18^{b}	28.30±1.22^{a}	9.31±0.49^{a}
P2 (32%)	12	7.45±0.18^{a}	26.25±1.22^{a}	9.25±0.49^{a}
Covering area				
C1 (75%)	12	6.55±0.18^{b}	30.60±1.22^{a}	9.86±0.49^{a}
C2 (100%)	12	7.65±0.18^{a}	23.95±1.22^{b}	8.70±0.66^{a}
Interactions (P×C)				
T1 (P1×C1)	6	6.00±0.26^{b}	32.90±1.73^{a}	10.12±0.66^{a}
T2 (P1×C2)	6	7.50±0.26^{a}	23.70±1.73^{b}	8.50±0.66^{a}
T3 (P2×C1)	6	7.10±0.26^{ab}	28.30±1.73^{ab}	9.60±0.66^{a}
T4 (P2×C2)	6	7.80±0.26^{a}	24.20±1.73^{b}	8.90±0.66^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different ($P \leq 0.05$)

Growth Parameters

The First Period: At the start of the experiment, all fish has almost similar body weight (BW) and body length (BL). As shown in Table (3), the initial body weight (1.03, 1.03, 1.04 and 1.03g) and body length (1.90, 1.90, 1.91 and 1.92 cm) for fish reared before over-wintering regimes in the different treatments, respectively. The differences in initial BW and BL among the different treatments were insignificant indicating the random distribution of fish around the different experimental treatments. At the end of the first period the averages of BW were 6.21, 7.50, 6.25 and 7.75g and Bl found to be 8.09, 8.57, 8.93 and 9.07 cm for the treatments T1, T2, T3 and T4, respectively. The differences among treatments were significant ($P<0.05$). These results indicated that, increasing dietary protein level is the main reason for increasing fish body weight and body length. Abou Seif [19] and Soltan *et al*. [20, 21] found that, there are significant differences in growth parameters of Nile tilapia, *O. niloticus* fed the diet supplemented or did not supplemented with amino acids before and during over-wintering.

As shown in Table (4), the the averages of initial condition factor (K) for fish reared before over-wintering for the different four treatments were 14.94, 14.95, 14.97 and 14.58, respectively. At the end of this period the averages values of (K) were 1.17, 0.96, 1.05 and 1.03 for the four treatments T1, T2, T3 and T4, resspectively. The differences among treatments were significant ($P<0.05$). Jeppesen *et al*. [22] found that, condition factor (K) was significantly affected by both temperature and food availability and there was a significant temperature food interaction.

The averages of daily weight gain (DWG) for fish reared before over-wintering regimes were 0.085, 0.082, 0.110 and 0.110 for treatments T1, T2, T3 and T4, respectively (Table 4). Analysis of variance indicated that the studied factors, protein level and over-wintering systems were significantly affected DWG of Nile tilapia fry during winter months. Soltan *et al*. [20, 21] found that, the addition of (L- carnitine) in fish diet incresed the DWG in Nile tilapia during over-wintering period. Schlechtriem *et al*. [23] stated that, the effects of L-carnitine and lysine supplementation on fish culture and nutrition and found that, DWG for hybrid tilpia incresd by addition of L-carnitine and lysine supplementation.

Table 3: Effect of dietary protein and covering area of ponds on body weight (gm) and body length (cm)

Variable	No.	Initial weight	Final weight	Initial length	Final length
T1 (P1×C1)	60	1.03±0.02^{a}	6.21±0.80^{c}	1.90±0.07^{b}	8.09±0.90^{b}
T2 (P1×C2)	60	1.03±0.02^{a}	7.50±0.80^{b}	1.90±0.07^{b}	8.57±0.90^{ab}
T3 (P2×C1)	60	1.04±0.02^{a}	6.25±0.80^{c}	1.91±0.07^{ab}	8.93±0.90^{ab}
T4 (P2×C2)	60	1.03±0.02^{a}	7.75±0.80^{a}	1.92±0.07^{a}	9.07±0.90^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different ($P \leq 0.05$).

Table 4: Effect of dietary protein and covering area of ponds on condition factor (K), daily weight gain (DWG) and specific growth rate (SGR)

Variable	No.	Initial (K)	Final (K)	DWG	SGR
T1 (P1×C1)	60	1.90±0.07^{b}	8.09±0.90^{b}	0.085±0.005^{b}	2.93±0.27c
T2 (P1×C2)	60	1.90±0.07^{b}	8.57±0.90^{ab}	0.082±0.005^{b}	3.24±0.27^{b}
T3 (P2×C1)	60	1.91±0.07^{ab}	8.93±0.90^{ab}	0.11±0.005^{a}	2.90±0.27^{c}
T4 (P2×C2)	60	1.92±0.07^{a}	9.07±0.90^{a}	0.11±0.005^{a}	3.31±0.27^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different ($P \leq 0.05$)

As described in Table (4), specific growth rate (SGR) for fish reared before over-wintering regimes were 2.93, 3.24, 290 and 3.31 for the different treatments T1, T2, T3 and T4, respectively. Analysis of variance indicated that protein level and covering area were significantly affected specific growth rate (SGR) of Nile tilapia fry during winter months. Abou Seif [19] when studied the effect of L-carnitine suppemented before over-wintering found that, growth parameters (DWG, SGR and RGR) were significantly higher (P<0.05) in fish group reard with L-carnitine supplemented diet than that of groups of reared without L-carnitine supplemented.

The Second Period: Tables (5 and 6) shows the effect of dietary protein (25 and 32%) and two covering areas (75 or 100% of the pond surface) by polyethelene sheet of rearing ponds on body weight of mon-osex *O. niloticus* during the second period (Over-wintering). The major goal in the over-wintering of tilapia fingerlings is to imrpove survival rate and and keep the fish in good condition for future growth period in the production ponds [24].

With respect of protein level regardless of covering area, Table (5) show that, the initial body weights were 5.63 and 7.32g and body length were 8.03 and 8.60cm, respectively. While at the end of experiment the averages of body weight for treatments were 32.54 and 39.78g and body length 13.64 and 14.43cm for the two protein levels 25 and 32%, respectively. These results indicate that, the high dietary protein content showed the highest BW and BL of mono sex *O. Niloticus* during over-wintering period.

With respect to the effect of covering area regardless of dietary protein, results of Table (5) indicated that, the initial body weight were 6.05 and 6.90g and body length 8.11 and 8.52cm, for fish fed the diets contained 25 and 32%, respectively. While at the end of experiment the averages of body weight for different treatments were 27.96 and 44.36g and body length 11.53 and 13.55cm for the two covering area 75 and 100%, respectively. The obtained results indicated that, the average body weight for covering area 100% was higher than 75% and the differences were significant (P<0.05).

The effect of interaction between protein levels and covering area on body weigth (Bw) and body length (BL) of monosex *O. niloticus* (Table 5) indicated that these two factors act dependently on each other and also each of them had its own significant effect. Results indicated that fish fed the high diatary protein content with complete coverining the experimental ponds with plastic sheets significantly relaesd the highest body weight and length.

The obtained result showed the importance of over-wintering and benefit from protein level and fats in fish diets. Abdel-Aal [25] found that, the best growth performance were obtaind in fish group reared in ponds that totally covered by polyethylene sheet, water depth had a significant effects on growth performance and survival rate.. Abou Seif [19] found that, there are significant differences between the Fish supplemented with amino acids to diet compared to the control group.

Regardless the effect of covering area, results outlined in Table (6) show that, the initial condition values (K) were 1.07 and 1.04 for fish groups fed the two dietary protein 25 and 35%, respectively. While at the end of experiment the averages of (K) for treatments were 1.49 and 2.07 for the two protein levels 25 and 32%, respectively. These results indicate that, the average (K) for protein level 32% was higher than protein level 25% and the differences among treatments were significant (P<0.05). With respect to the effect of pond covering area, data of the same table (6) showed that, the initial (K) were 1.11 and 1.00, respectively. At the end of experiment the averages of (K) found to be 1.89 and 1.69 for the two covering area 75 and 100%, respectively. These results indicate that, the average (K) for covering area 100% was higher than other treatment and the differences among treatments were not significant.

Table 5: Effect of dietary protein and covering area of ponds on body weight (gm) and body length (cm)

Variable	No.	Initial weight	Final weight	Initial length	Final length
Protein level (P)					
25% (P1)	120	5.63±0.74^{b}	32.54±0.32^{b}	8.03±0.69^{a}	13.64±0.79^{a}
32% (P2)	120	7.32±0.74^{a}	39.78±0.32^{a}	8.60±0.69^{a}	14.43±0.79^{a}
Covering area (C)					
75% (C1	120	6.05±0.74^{a}	27.96±0.33^{b}	8.11±0.68^{a}	11.53±0.79^{b}
100% (C2)	120	6.90±0.74^{a}	44.36±0.33^{a}	8.52±0.68^{a}	13.55±0.79^{a}
Interaction (P×C)					
T1 (P1×C1)	60	6.21±0.80^{c}	25.42±1.76^{d}	8.09±0.90^{b}	11.30±1.17^{d}
T2 (P1×C2)	60	7.50±0.80^{b}	39.67±1.76^{b}	8.57±0.90ab	13.76±1.17^{b}
T3 (P2×C1)	60	6.05±0.80^{c}	30.51±1.76^{c}	8.93±0.90^{ab}	12.14±1.17^{c}
T4 (P2×C2)	60	7.75±0.80^{a}	49.05±1.76a	9.07±0.90^{a}	14.61±1.17^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different (P$\leq$ 0.05).

Table 6: Effect of dietary protein and covering area of ponds on condition factor (K), daily weight gain (DWG) and specific growth rate (SGR)

Variable	No.	Initial K	Final K	DWG	SGR
Protein level (P)					
25% (P1)	120	1.07±0.12^{a}	1.49±0.04^{b}	0.20±0.04^{a}	1.27±0.09^{a}
32% (P2)	120	1.04±0.12^{a}	2.07±0.04^{a}	0.24±0.04^{a}	1.24±0.09^{a}
Covering area (C)					
75% (C1)	120	1.11±0.12^{a}	1.89±0.04^{a}	0.16±0.04^{b}	1.13±0.09^{b}
100% (C2)	120	1.00±0.12^{a}	1.69±0.04^{a}	0.27±0.04^{a}	1.37±0.09^{a}
Interaction (P×C)					
T1 (P1×C1)	60	1.17±0.18^{a}	1.83±0.05^{b}	0.15±0.06^{c}	1.17±0.11^{c}
T2 (P1×C2)	60	0.96±0.18^{b}	1.94±0.05^{b}	0.25±0.06^{b}	1.36±0.11^{b}
T3 (P2×C1)	60	1.05±0.18^{ab}	1.20±0.05^{d}	0.17±0.06^{c}	1.09±0.11^{d}
T4 (P2×C2)	60	1.03±0.18^{ab}	2.29±0.05^{a}	0.30±0.06^{a}	1.38±0.11^{a}

a, b, c ± Means with the same letter in each column for each factor were not significantly different (P$\leq$ 0.05)

The effect of the interaction between dietary protein levels and covering area of rearing ponds by sheets showed that, the averages of (K) values were 1.17, 0.96, 1.05 and 1.03 while at the end of this period these averages were 1.83, 2.29, 1.20 and 1.61 for the differet treatments T1, T2, T3 and T4, resspectively and the differences among treatments were significant (P<0.05). Soltan *et al*. [21] found that, K values ranged between 1.60 to 1.86 with significant differences between the tested over-wintering regimes of *Oreochromis niloticus*. K values obtained in the present study relatively similar to that recorded by many authors [26-28] for the same fish specie, *O. niloticus*.

During over-wintering period dietary protein levels (25 or 32%) had no significant effect on daily weight gain (DWG) or specific growth rate (SGR) while covering area 75 or 100%) of experimental ponds had a significant effect of DWG and SGR and the complete covering area (100%) showed highest DWG and SGR compared to 75% covering area of the experimental area and the same trend was also observed for SGR. Abdel-Aal [25] tested the effect of over-wintering and water depth on growth performance and survival rate of *O. niloticus* L. and he found that reared fish covered by polyethylene sheet showed best grouth performance than other treatments.

Chemical Composition: Chemical analysis at the end of a feeding trial is frequently used to determine the influence of feed on fish body composition. According to Hanley [30] endogenous factors (Size, sex and stage of life cycle) and exogenous factors (Diet composition, feeding frequency, temperature etc.) affect the body composition of fish. It should be noted that within endogenous factors, the composition of the feed is only the factor, which could have influenced the chemical composition of fish body, as other endogenous factors were maintained uniform during the study.

As described in Table (7) fish fed diet contained 32% released the highest values of protein, fat and ash which significantly different from the diet 25% for protein content only. Similar results were obtained for the same specie by many authors [31-33]. Covering area of the experimental ponds also significantly affected protein and fat content of fish where fish reared in the complete covered ponds (100%) released the highest protein, fat and ash percentages.

Table 7: Effect of dietary protein and covering area of ponds on chemical composition % DM basis of Nile tilapia

Variable	No.	Moisture	Protein	E. ext.	Ash
Protein level (P)					
25% (P1)	12	71.69±0.89[a]	64.84±0.77[b]	20.25±0.28[a]	14.78±0.21[a]
32% (P2)	12	71.32±0.89[a]	66.44±0.77[a]	20.83±0.28[a]	14.98±0.21[a]
Covering area (C)					
75% (C1)	12	71.85±0.89[a]	64.01±0.77[b]	19.93±0.28[b]	14.84±0.21[a]
100% (C2)	12	71.16±0.89[a]	67.27±0.77[a]	21.15±0.28[a]	14.92±0.21[a]
Interaction (P×C)					
T1 (P1×C1)	6	72.13±1.09[a]	62.89±0.94[c]	19.42±0.34[c]	14.90±0.27[b]
T2 (P1×C2)	6	71.24±1.09[b]	66.78±0.94[a]	21.07±0.34[a]	14.65±0.27[b]
T3 (P2×C1)	6	71.56±1.09[b]	65.12±0.94[b]	20.44±0.34[b]	14.77±0.27[b]
T4 (P2×C2)	6	71.09±1.09[b]	67.75±0.94[a]	21.22±0.34[a]	15.18±0.27[a]

a, b, c ± Means with the same letter in each column for each factor were not significantly different ($P \leq 0.05$).

Table 8: Effect of dietary protein and covering area of ponds on survival rate of Nile tilapia

Variable	Survival rate%
Protein level (P)	
25% (P1)	76.61%
32% (P2)	83.66%
Covering area (C)	
75% (C1)	67.69%
100% (C2)	92.59%
Interaction (P×C)	
T1 (P1×C1)	64.14%
T2 (P1×C2)	89.08%
T3 (P2×C1)	71.23%
T4 (P2×C2)	96.09%

The interaction between the two factors studied dietary protein content and covering area show that, T4 released the highest protein, fat and ash content which did not significantly different from those recorded by T2. Suman and Samir [34] found that, pond culture in warm water showed the highest protein content compared with pond culture in cold water among all the culture methods. Although fat content is the highest in warm water culture system, pond culture also has a high fat content belonging to the same homogenous category.

Survival Rate (%): As shown in Table (8) the highest dietary protein content (32%) and complete covering of experimental ponds showed the highest survival rate compared to the lowest dietary protein and the 75% covering area of ponds. For all studied treatments T4 showed the highest survival rate. This may be due to increasing water temperature and reduce the mortality rates of fry. This result is in agreement with Bakeer *et al.* [35, 36] and Soltan *et al*. [21]. Crab *et al*. [24] demonstrated that, temperature in the covered ponds with polyethylene sheets could easily be controlled and was 0.4-4.9°C higher than the influent water and hybrid tilapia fingerlings (*O. niloticus* × *O. aureus*) survival rates were excellent being 97± 6% for 100 g fish and 80±4% for 50g fish and these findings can help to overcome over-wintering problems, particularly mass mortality of fish due to low temperatures in the ponds.

CONCLUSION

Based on the results obtained in the present study, it can be concluded that feeding fry *O. niloticus* on diet contained 32% protein before and during the winter season, taking into account the 100% coverage of concrete ponds by polyethylene sheet during the winter months has led to increasing survival rate and increase the weights fish at the end of the season, in spite of feeding fish for all treatments during the growing season on a diet containing 25% crude protein.

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