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Effect of protein level and stocking density on growth performance of Nile tilapia (*Oreochromis niloticus*) Cultured in tanks.

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SUMMARY

An experiment was conducted at the fish experimental station of the Al-Azhar university, Faculty of Agriculture to study the effect of dietary plant protein level (25% and 30 %) and stocking density (50 and 100 fish/m^3) on performance of Nile tilapia (*Oreochromis niloticus*) during the period from 1.5. 2000 to 31.10.2000. Four circular fiberglass tanks each of one cubic meter of volume used representing four treatments two protein levels and two stocking densities. Results obtained can be summarized as follows:

- Regardless of stocking density increasing the protein level fed from 25% to 30% increased significantly ($P<0.05$) the body weight during all experimental periods. On the other hand, increasing the stocking density from 50 to 100 fish/m^3 decreased significantly body weights regardless of protein level fed.
- Increasing dietary protein level from 25 to 30 % increased significantly fish body length, regardless of stocking density. On the other hand increasing the stocking density from 50 to 100 fish/m^3 decreased body length of Nile tilapia during the experimental periods.
- Increasing the protein level fed improved the specific growth rate regardless of stocking density tested. Also increasing the stocking density caused a decrease in the specific growth rate of Nile tilapia.
- Increasing the protein level fed improved feed conversion ratio, regardless of stocking rate. Also, fish at lower stocking density showed better feed conversion ratio compared to that at higher one. Other results are also discussed.

INTRODUCTION

Tilapia species are presently the most intensive cultivated fresh water fish in Egypt. Diets containing 25% protein are mostly extruded and usually used for feeding tilapia. In practice tilapia fed these diets reach marketable size (100 g or more) in 90-120 days. However, Nile tilapia (31 g) fed graded dietary protein from 14% to 30% raised under laboratory conditions grow up to 100 g without significant differences in growth rate (El-Dahhar et al., 1999) and the use of low quality protein even at high level of dietary protein leads fish to use protein as a source of energy which increase ammonia secretion and deteriorate water quality. Therefore, determination of protein requirements for intensive tilapia production has been the aim of many studies (Shiau and Huang, 1989; Shiau and Huang, 1990; De Silva et al., 1991; El-Sayed and Tashima, 1992; Hassanen et al., 1998; El-Dahhar et al., 1999 and Khalil, 1999).

Economic success of controlled fish production depends mainly on feed costs, particularly that of protein, since protein is always the most expensive component in artificial fish diets, therefore the determination of nutritional requirements of the fish and the composition of the diet in the determination of the feeding rate may help in saving feed and increasing the farm profitability. This study was therefore conducted to investigate the effect of protein level and stocking density on performance of Nile tilapia *Oreochromis niloticus* reared in rectangular tanks.

MATERIALS AND METHODS

The present study was carried out at the experimental fish station of Department of animal production, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

Facilities and fish:

The experiment started on the 1^{st} June 2000 and lasted until the 1^{st} November of the same year. Four rectangular tanks each with $1 \times 2 \times 0.5$ m^3 were used in this study to provide a total water volume of one cubic meter. The four tanks represent two stocking density 50 and 100 fish/ m^3 and within each density studied two protein levels (25 and 30%) were tested.

The experimental fish were obtained from San El-Haggar hatchary, Sharkiya Governorate. Fish were transported in a tank and after arrival to the experimental fish station adapted to the new conditions for 7 days, then distributed randomly into four fiberglass tanks represents four treatments. The initial weights of the fish at the start of the experiment was 28.06±0.4 g . Fish were fed on the experimental diets two times daily (9 a.m. and 2 p.m.) six days a week at a rate 3% of their biomass weight. Feed amounts were monthly adjusted on basis of the new fish weight.

Experimental diets:

Two experimental diets were formulated to contain 25 and 30% crude protein. Feed ingredients of the diet were thoroughly mixed using a vertical mixer, then the mix was made into moist past by addition of water at a rate of 25% of the diet weight. The past was then extended through a commercial mincing machine from which the cutting blades have been removed. The resulting spaghetti like diet (5mm diameter) was then sun dried for 14 hours before fed to the experimental fish. Composition of the two experimental diets is illustrated in Table (1). The two tested diets were analyzed for dry matter, crude protein, Ether extract (EE) and ash contents according to A.O.A.C. (1990).

Growth performance parameters:

Live body weight and length of individual fish at start and monthly recorded. Specific growth rate (SGR) was calculated using the following equation:-

$SGR\% = 100(LnW_2 - LnW_1)/T_2 - T_1$

where W_2 is the weight at T_2 and W_1 is the weight at T_1 and Ln is the natural log.

Feed efficiency parameters:

Feed conversion ratio (FCR) was calculated monthly by using the following equation:

FCR = dry feed ingested/weight gain.

Also, protein efficiency ratio (PER) was determined according to the following equation:

PCR = weight gain (g)/protein ingested (g)

Carcass and chemical analysis:

At the experimental end 6 fish were taken randomly from each treatment. 3 fish were exposed to carcass test as described by Lovell (1981) and flesh of each individual fish were chemically analyzed for their proximate analysis. The other 3 fish were used for the chemical analysis of the whole fish body according to the methods of A.O.A.C. (1990).

Statistical analysis:

The statistical analysis of data was carried out by applying the computer program Harvey (1990) by adopting the following fixed model.

$$\mathbf{Y_{ijk} = \mu + P_i + S_j + (PS)_{ij} + e_{ijk}}$$

where:

Y_{ijk} = observation of the ijk-th fish
μ = overall mean
P_i = fixed effect of the i-th protein level
S_j = fixed effect of the j-th stocking density.
$(PS)_{ij}$ =interaction between the effect of i-th protein level and j-th stocking density
e_{ijk} = random error assumed to be independently randomly distributed (0, δ^2e).

Differences among means were tested for significance according to Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

Specific growth rate (SGR):

Results of SGR as affected by protein levels (25 and 30%) and stocking density (50 and 100 fish/m^3) tested by the present experiment are illustrated in table (2). As described in this table, SGR values decreased from 1.38 to 0.58 for the low to 0.66 for the high protein level (25% and 30%), respectively, indicating that fish fed the diet with high protein level showed the high SGR compared with those fed diet with the low protein level. Average SGR values during the whole experimental period (0-150 days) were 0.86 and 1.07 for the low and the high protein level indicating that SGR increased with the increase of diet protein level.

As described in table (2) increasing the stocking density from 50 to 100 fish/m^3 decreased SGR at all studied periods and this trend was observed during the whole experiment i.e (0-150 day) where SGR were 1.12 and 0.81 for the low and high stocking densities, respectively. These results indicate that fish at lower stocking density fish grow better than those stocked at higher densities. These results are in agreement the findings of Eid and El-Gamal (1997), who reported that SGR of Nile tilapia (average initial weights 30.0-30.1 g) reared in cages at densities of 50, 70, 75, 100, 125 and 200 fish/m3 for 120 days were 1.14, 1.34, 1.21, 1.17, 1.02 and 0.89%, respectively. Also, Al-Azab (2001) found that SGR for Nile tilapia fed at a feeding rate of 4% of the total biomass and stocked at 50, 100 and 150 fish/m3 were 1.10, 1.02 and 0.95, respectively, but when fish fed at a feeding rate of 8% the corresponding values were 1.18, 1.11 and 1.06%, respectively.

With regard to the interaction between protein level and stocking density it I ticed that the best SGR was recorded by fish fed with the high protein level diet (30%) and reared with the low stocking density 1.23 and 0.69, respectively (table 2).

Feed conversion ratio (FCR):

Results of table (3) show averages feed conversion ratio for fish fed diets with 25% and 30% crude protein at two stocking densities 50 and 100 fish/m^3. Average FCR values during the whole experimental period (0-150 day) were 3.12 and 2.62 for 25% and 30% protein levels, respectively. This trend also observed for most of experimental periods indicating that, the FCR improved with the increase in diet protein level. These results are in accordance with those reported by Muthukmarana and Weerakoon (1986), who stocked *O. nloticus* fingerlings in cages at stocking densities of 400, 600, 1000 and 1200 fish/m3 and fish fed on either 17% or 20% protein diet for 150 days, they reported that FCR improved with each increase in diet protein level and each decrease in stocking density. Also, De Silva et al., (1991) found that, FCR for red tilapia was improved from 2.32, 1.67 and 1.51 for fish fed diets contained 12% lipid in three protein levels 15, 20 and 25%, respectively and the same trend was also observed when lipids content increased to 18% (1.82, 1.35 and 1.18) and diets with 24% lipids (2.11, 1.40 and 1.10) for the three protein levels, respectively.

As illurated in table (3), the average FCR during the whole experiment period (0-150 day) were 2.27 and 3.34 for the low and high stocking densities, respectively and this indicated that, FCR values decreased with each decrease in stocking density. The same trend was observed for fish fed the two diets tested in this experiment. Similar results observed by Al-Azab (2001) who stocked *O. niloticus* fingerlings with initial weight of 29.7-30.5 g in fiberglass tanks at stocking densities of 50 100 and 150 fish/m3 and fish fed 4% or 8% of the total biomass and he found that FCR were 3.37, 3.48 and 3.62 for fish fed 4% of the total biomass and the corresponding values were 6.53, 6.61 and 6.70 for fish fed 8% of the total biomass, respectively. Also, these results are in accordance with those reported by Muthukmarana and Weerakoon (1986). Suresh and Lin (1992); Siddiqui et al., (1992); Yang et al., (1996) and Eid and El-Gamal (1997) they concluded that FCR for improved with decrease in the stocking density. On the other hand Watanabe et al., (1990) show that FCR of monosex Florida red tilapia held in cages did not differ at densities ranged from 100 to 300 fish/m^3.

Protein efficiency ratio (PER):

Average PER of the earlier periods 0-30 days and 30-60 days were improved for fish fed the high protein level (3.48 and 2.03 respectively) compared with 2.62 and 1.64 for fish fed the low protein level and the opposite trend was observed during the rest experimental periods i.e 60-90, 90-120 and 120-150 days and the PER for the whole experimental period was slightly different, 1.28 and 1.27 for fish fed the low (25%) and high (30%) protein level, respectively. Shiau and Huang (1989) found that PER for Nile tilapia fed purified diets ranging from 0% to 56% protein in 8% increments crude protein were decreased with increasing dietary protein level. Also, De Silva et al., (1991) found that, PER for red tilapia fed diets contained 15, 20 and 25% crude protein were 2.55, 2.89 and 1.51 when diets contained 12% lipid and 3.25, 3.56 and 3.06 when diets contained 18% lipids and 2.88, 3.49 and 3.30 for diets contained 24% lipids.

As shown in table (3) during the whole experimental period PER decreased from 1.60 to 1.09 when stocking density increased from 50 to 100 fish/m^3 and the same trend was observed for all experimental periods. i.e 0-30 days (3.81 to 2.42), 30-60 days (2.29-1.42); 60-90 days (1.14 to 0.85); 90-120 days (1.33 to 1.03) and 120-150 days (1.05 to 0.84), respectively. Moustafa (1993) reported that, the average PER in Nile tilapia stocked in cages at densities of 80, 100, 120 and 140 fish/m^3 decreased decreased from 1.60; 1.50; 1.40 and to 1.30, respectively. Similar results obtained by Eid and El-Gamal (1997), who reported that, PER in Nile tilapia cultured in cages or concrete and fiberglass tanks decreased as the fish density increased from 50, 75, 100, 125, 150 and 200 fish/m^3. Also Al-Azab (2001) found that PER for Nile tilapia decreased from 0.85, 82 and 0.79 when fish fed at a feeding rate of 4% of the total biomass and also decreased from 0.44, 43 and 0.42 when fish fed a t a feeding rate of 8% of the total biomass and stocking densities of 50, 100 and 150fish/m^3, respectively.

Body weight (BW):

As presented in table (5) average of initial weights ranged between 28.15 and 27.98 for the two protein levels 25 and 30%, respectively with no significant differences between the two tested groups. Four weeks after experimental start, averages of body weights for fish fed the two experimental diets 25 and 30% crude protein were 42.55 and 50.78 g , respectively with significant differences between the two groups and this trend was also observed until the experimental end. The present data indicated that, increasing protein level in diets followed by increase the fish body weight and this may be attributed to the availability of amino acids required for growth. Watanabe et al., (1990) reported that, protein level in the diet released significant effects on body weights for the favour level of 32% protein compared to the 28% level.

With regard to stocking density, table (5) show that, when stocking density was doubled, body weights were significantly ($P<0.001$) decreased after four weeks from experimental start until the experimental end. The decrease in body weight with increasing fish stocking density may be attributed to the reduced feed intake due to the computation between individuals at the higher stocking density. The present results are in agreement with the findings of Sadek et al., (1992); Suresh and Lin (1992) and Al-Azab (2001).

With regard to the interaction between protein level and stocking density table (5) show that, the higher body weights were recorded with the third treatment where fish stocked with the low stocking density (50 fish/m^3) and fed the diet with the high protein level (30%) and the lower body weights were recorded by the second treatment where fish stocked at the high stocking density (100 fish/m^3) and fed the diet with low protein level (25%).

Body length (BL):

Averages of body length as affected by diet protein levels (25 and 30%) indicated that, increasing diet protein level subsequently followed by significant increase the body length at all studied experimental periods (table 6) and these results were in accordance with those reported by Khalil (1999) who found that, body length increased with each increase in diet protein level.

Also table (6) indicated that, increase of stocking density from 50 to 100 fish/m3 followed by decrease in fish body length with significant differences at all experimental periods. These results are in agreement with the findings of Watanab et al., (1990) and Al-Azab (2001) who reported that a significant effect of stocking density of tilapia body length.

With regard to the interaction between protein level and stocking density table (5) show that, the higher body lengths were recorded with the third treatment where fish stocked with the low stocking density (50 fish/m^3) and fed the diet with the high protein level (30%) and the lower body lengths were recorded by the second treatment where fish stocked at the high stocking density (100 fish/m^3) and fed the diet with low protein level (25%).

Carcass characteristics:

Results of carcass traits as affected by diet protein level and stocking density tested are illustrated in table (7). Results revealed that, increasing diet protein level from 25% to 30% followed by decrease in dressing percentage from 49.44 to 4.06%, flesh from 37.23 to 35.68%, skeleton from 10.89 to 10.37 and viscera from 9.62 to 9.28%, but the percentages of head, scales, fins and total by-products were increased from 33.11 to 35.18; 2.09 to 2.32; 3.96 to 4.01% and 59.70 to 60.94%, respectively with insignificant differences between the two diets tested.

With regard to stocking density table (7) revealed that, increasing stocking density from 50 to 100 fish/m^3 subsequently followed by decrease in the percentages of dressing (50.28 to 47.22%) and flesh (38.29 to 34.62%) and increase in the percentages of total by-products (from 59.21 to 61.43%) with significant differences between the two stocking densities tested. Results of stocking density revealed that, the increase in stocking density resulted in decrease in the edible parts of Nile tilapia and increase the non edible parts of Nile tilapia carcasses. These results are in agreement with those obtained by Shahat (1991); Moustafa (1993) who showed that dressing percentages of Nile tilapia decreased significantly with each increase in stocking density.

Chemical composition:

A. Whole fish:

As illustrated in table (8), when protein level increased from 25 to 30%, the percentages of moisture, protein and ash were decreased from 75.22 to 73.93%; 55.58 to 52.24% and 24.90 to 23.54%, respectively and the percentage of fat increased from 11.32 to 11.98% with insignificant effect of protein level on the above components. Shiau and huang (1989) found that, fish fed the lower dietary protein levels (0, 8 and 16%) had significantly lower protein content than fish fed the higher dietary protein levels (24, 32, 40, 48 and 56%). Fish fed diets with lower protein levels (8 and 12%) had higher lipid content than fish fed with higher protein levels although the differences were not significant, and fish fed the lower protein diets (8, 16 and 24%) had significantly lower moisture content than those fed higher protein diets (32, 38, 40, 48 and 56%) and ash content in tilapia was not affected by the protein level in the diet.

With concerning to the chemical analysis of Nile tilapia as affected by stocking density, table (8) revealed that, increasing stocking density (from 50-100 fish/m^3) released an increase in the percentage of moisture (73.50 to 75.65%); protein (51.98 to 55.84%) and ash (21.18 to 27.26%) but the fat percentage decreased from 15.29 to 10.01% and the differences are not significant. Similar results were obtained by Moustafa (1993) and Khouraiba (1989).

B. Flesh:

As shown in table (8) diet protein levels had no significant effect on the percentages of moisture, protein, fat and ash, and the same results wee recorded for the effect of stocking density on the chemical composition of fish flesh except for the percentage of fat whereas the increase in stocking density (from 50 to 100 fish/m^3) followed by decrease in the fat percentage from 6.98 to 3.76%, respectively. De Silva et al., (1991) revealed that, tilapia carcass lipids content increased with increasing dietary lipid at all three protein levels (15, 20 and 25%) and the increase being decreasingly noticeable with increasing dietary protein level and the opposite trend was observed with carcass protein.

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Table (2): Means and standard error (Mean±SE) for the effect of protein level and stocking rate on specific growth rate (SGR) of *O. niloticus.*

Variable	No.	0-30 day	30-60	60-90	90-120	120-150	0-150
Protein level (P)							
Low (25%)	2	1.38	0.93	0.69	0.74	0.58	0.86
High (30%)	2	1.99	1.30	0.63	0.78	0.66	1.07
Stocking rate (SR)							
SR1 (50 fish/ tank)	2	1.99	1.34	0.73	0.84	0.68	1.12
SR2 (100 fish/ tank)	2	1.39	0.88	0.56	0.67	0.56	0.81
P × SR							
P1×SR1	1	1.70	1.15	0.70	0.85	0.58	0.99
P1×SR2	1	1.00	0.62	0.96	0.57	0.59	0.69
P2×SR1	1	2.30	1.52	0.76	0.82	0.76	1.23
P2×SR2	1	1.71	1.06	0.47	0.73	0.53	0.90
Overall mean	4	1.70	1.14	0.66	0.77	0.63	0.98

Table (3): Means and standard error (Mean±SE) for the effect of protein level and stocking rate on feed conversion ratio of *O. niloticus.*

Variable	No.	0-30 day	30-60	60-90	90-120	120-150	0-150
Protein level (P)							
Low (25%)	2	1.53	2.44	3.37	3.12	4.09	3.12
High (30%)	2	0.96	1.64	3.76	2.95	3.55	2.62
Stocking rate (SR)							
SR1 (50 fish/ tank)	2	0.96	1.57	3.18	2.74	3.46	2.27
SR2 (100 fish/ tank)	2	1.50	2.56	4.29	3.53	4.31	3.34
P × SR							
P1×SR1	1	1.18	1.90	3.36	2.67	4.11	2.64
P1×SR2	1	2.54	3.77	3.37	4.15	4.07	3.62
P2×SR1	1	0.78	1.45	3.16	2.69	3.02	2.01
P2×SR2	1	1.21	2.05	5.14	3.18	6.41	3.17
Overall mean	4	1.18	1.92	3.59	3.02	3.76	2.82

Table (4): Means and standard error (Mean±SE) for the effect of protein level and stocking rate on protein efficiency ratio (PER) of *O. niloticus.*

Variable	No.	0-30 day	30-60	60-90	90-120	120-150	0-150
Protein level (P)							
Low (25%)	2	2.62	1.64	1.19	1.28	0.98	1.28
High (30%)	2	3.48	2.04	0.89	1.13	0.94	1.27
Stocking rate (SR)							
SR1 (50 fish/ tank)	2	3.81	2.29	1.14	1.33	1.05	1.60
SR2 (100 fish/ tank)	2	2.42	1.42	0.85	1.03	0.84	1.09
P × SR							
P1×SR1	1	3.40	2.10	1.19	1.50	0.97	1.52
P1×SR2	1	1.80	1.06	1.19	0.96	0.98	1.10
P2×SR1	1	4.27	2.30	1.06	1.24	1.10	1.66
P2×SR2	1	2.75	1.63	0.65	1.05	0.52	1.05
Overall mean	4	3.09	1.89	1.01	1.20	0.97	1.29

Table (5): Means and standard error (Mean±SE) for the effect of protein level and stocking rate on the body weight (BW) of *O. niloticus.*

Variable	No.	BW1	BW2	BW3	BW4	BW5	BW6
Protein level (P)							
Low (25%)	150	28.15±0.57 a	42.55±0.74 b	56.18±1.02 b	69.17±1.13 b	86.48±1.49 b	102.98±2.68 b
High (30%)	150	27.98±0.57 a	50.78±0.74 a	75.00±1.02 a	90.54±1.13 a	114.48±1.49 a	139.62±2.68 a
Stocking rate (SR)							
SR1 (50 fish/ tank)	100	27.11±0.66 b	49.26±0.86 a	73.70±1.18 a	91.77±1.30 a	118.00±1.72 a	144.62±3.10 a
SR2 (100 fish/ tank)	200	29.02±0.47 a	44.07±0.61 b	57.48±0.83 b	67.94±0.92 b	82.96±1.21 b	97.98±2.18 b
P × SR							
P1×SR1	50	28.94±0.93 ab	48.14±1.21 a	67.89±1.67 b	83.65±1.84 b	108.09±2.42 b	128.60±4.37 b
P1×SR2	100	27.36±0.66 bc	36.96±0.86 b	44.47±1.18 c	54.70±1.30 c	64.87±1.72 d	77.36±3.09 c
P2×SR1	50	25.28±0.93 c	50.37±1.21 a	79.51±1.67 a	99.90±1.84 a	127.91±2.42 a	160.64±4.37 a
P2×SR2	100	30.67±0.66 a	51.19±0.86 a	70.48±1.18 b	81.18±1.30 b	101.05±1.71 c	118.60±3.10 b
Overall mean	300	28.06±0.40	46.67±0.53	65.59±0.72	79.86±0.80	100.48±1.05	121.30±1.89
ANOVA							
		F- ratio					
S.O.V	df	BW1	BW2	BW3	BW4	BW5	BW6
Protein level (P)	1	0.046	61.365***	170.017***	179.137***	177.343***	93.778***
Stocking rate (SR)	1	5.623**	24.332***	126.399***	222.875***	277.750***	151.964***
P×SR	1	18.678***	32.662***	24.821***	10.263***	15.127***	1.479
Remainder df	296						
Remainder ms		43.29952	73.60219	138.81161	169.89	294.71034	954.215644

Means with the same letter in each column are not significantly different.
* P<0.05 ** P<0.01 *** P<0.001

Table (6): Means and standard error (Mean±SE) for the effect of protein level and stocking rate on the body length (BL) of *O. niloticus*.

Variable	No.	BL1	BL2	BL3	BL4	BL5	BL6
Protein level (P)							
Low (25%)	150	11.92±0.08 b	13.49±0.08 b	14.92±0.09 b	16.48±0.10 b	18.02±0.13 b	19.86±0.18 b
High (30%)	150	12.24±0.08 a	14.03±0.08 a	16.08±0.09 a	17.58±0.10 a	19.35±0.13 a	21.67±0.18 a
Stocking rate (SR)							
SR1 (50 fish/ tank)	100	12.00±0.09 a	14.22±0.09 a	16.06±0.10 a	17.70±0.11 a	19.73±0.15 a	22.50±0.20 a
SR2 (100 fish/ tank)	200	12.16±0.07 a	13.57±0.07 b	14.94±0.07 b	16.36±0.08 b	17.65±0.11 b	19.03±0.14 b
P × SR							
P1×SR1	50	12.18±0.13 b	14.30±0.13 a	15.84±0.15 b	17.36±0.16 b	19.16±0.21 b	21.43±0.29 b
P1×SR2	100	11.65±0.09 c	12.30±0.13 b	14.00±0.10 c	15.60±0.11 c	16.89±0.15 d	18.29±0.20 d
P2×SR1	50	11.81±0.13 c	14.14±0.13 a	16.27±0.15 a	18.04±0.16 a	20.30±0.21 a	23.58±0.29 a
P2×SR2	100	12.66±0.09 a	14.46±0.09 a	15.88±0.10 b	17.12±0.11 b	18.41±0.15 c	19.77±0.20 c
Overall mean	300	12.08±0.06	13.90±0.06	15.50±0.06	17.03±0.07	18.69±0.09	20.76±0.12
ANOVA							
		F- ratio					
S.O.V	df	BL1	BL2	BL3	BL4	BL5	BL6
Protein level (P)	1	7.903**	49.969***	82.825***	64.104***	53.035***	52.746***
Stocking rate (SR)	1	1.951	32.784***	76.523***	94.485***	129.499***	194.050***
P×SR	1	36.780***	71.645***	32.086***	9.237**	1.077	1.786
Remainder df	296						
Remainder ms		0.85299	0.876429	1.08309	1.26410	2.22190	4.15221

Means with the same letter in each column are not significantly different.
* P<0.05 ** P<0.01 *** P<0.001

Table (7): Means and standard error (Mean±SE) of the effect of protein level and stocking rate on the carcass analysis of *O. niloticus*.

Variable	No.	Dressing %	Flesh %	By-product %					
				Head %	Skeleton %	Viscera %	Scales%	Fins%	Total
Protein level (P)									
Low (25%)	6	49.44±0.64 a	37.23±0.93 a	33.11±0.83 a	10.89±0.31 a	9.62±0.85 a	2.09±0.06 b	3.96±0.13 a	59.70±0.58 a
High (30%)	6	48.06±0.64 a	35.68±0.93 a	35.18±0.83 a	10.37±0.31 a	9.28±0.85 a	2.32±0.06 a	4.01±0.13 a	60.94±0.58 a
Stocking rate (SR)									
SR1 (50 fish/tank)	6	50.28±0.64 a	38.29±0.93 a	32.24±0.83 b	10.99±0.31 a	10.15±0.85 a	2.14±0.06 a	3.78±0.13 a	59.21±0.58 b
SR2 (100 fish/tank)	6	47.22±0.64 b	34.62±0.93 b	36.4±0.83 a	10.27±0.31 a	8.75±0.85 a	2.27±0.06 a	4.19±0.13 a	61.43±0.58 a
P × SR									
P1×SR1	3	50.15±0.90 a	38.25±1.31 a	30.95±1.18 b	10.92±0.31 a	11.03±1.21 a	2.04±0.08 b	3.93±0.19 ab	58.70±0.83 b
P1×SR2	3	48.72±0.90 a	36.21±1.31 ab	35.26±1.18 a	10.86±0.31 a	8.20±1.21 a	2.14±0.08 ab	3.98±0.19 ab	60.70±0.83 ab
P2×SR1	3	50.40±0.90 a	38.33±1.31 a	33.53±1.18 ab	10.05±0.31 a	9.26±1.21 a	2.24±0.08 ab	3.63±0.19 b	59.73±0.83 ab
F2×SR2	3	45.72±0.90 b	33.03±1.31 b	36.82±1.18 a	9.69±0.31 a	9.29±1.21 a	2.39±0.08 a	4.39±0.19 a	62.15±0.83 a
Overall mean	12	48.75±0.45	36.46±0.65	34.14±0.59	10.63±0.22	9.45±0.60	2.20±0.04	3.99±0.10	60.32±0.41
ANOVA									
S.O.V	df	F-ratio							
				By-product					
		Dressing %	Flesh %	Head %	Skeleton %	Viscera %	Scales%	Fins%	Total
Protein level (P)	1	2.032	1.398	3.092	1.401	0.079	6.866*	0.088	2.232
Stocking rate (SR)	1	11.445**	7.816**	10.414**	2.631	1.348	2.144	4.55	7.157*
P×SR	1	3.218	1.545	0.186	2.186	1.400	0.120	3.437	0.064
Remainder df	8								
Remainder ms		2.4518	5.1788	4.1634	0.5829	4.3820	0.0225	0.1090	2.0504

Means with the same letter in each column are not significantly different.

* P<0.05 ** P<0.01 *** P<0.001

Table (8): Means, standard error and analysis of variance for the effect of protein level and stocking rate on the chemical analysis of Nile tilapia, *O. niloticus.*

Variable	No.	Whole fish				Flesh			
		Moisture%	Protein %	Fat %	Ash%	Moisture%	Protein %	Fat %	Ash%
At start	4	72.81±0.81	55.38±0.72	7.64±1.49	29.20±2.03				
At the experiment end									
Protein level (P)									
Low (25%)	6	75.22±0.81 a	55.58±1.46 a	11.32±1.67 a	24.90±1.64 a	77.68±0.37 a	81.96±1.37 a	5.75±0.69 a	6.34±0.28 a
High (30%)	6	73.93±0.81 a	52.24±1.46 a	13.98±1.67 a	23.54±1.64 a	78.68±0.37 a	81.01±1.37 a	4.99±0.69 a	6.33±0.28 a
Stocking rate (SR)									
SR1 (50 fish/ tank)	6	73.50±0.81 a	51.98±1.46 a	15.29±1.67 a	21.18±1.64 a	77.38±0.37 b	79.85±1.37 a	6.98±0.69 a	6.09±0.28 a
SR2 (100 fish/tank)	6	75.65±0.81 a	55.84±1.46 a	10.01±1.67 a	27.26±1.64 a	78.98±0.37 a	83.12±1.37 a	3.76±0.69 b	6.59±0.28 a
P × SR									
P1×SR1	3	72.77±1.15 b	52.95±2.07 a	18.22±2.49 a	18.90±2.32 b	77.08±0.53 b	80.85±1.94 a	7.48±0.98 a	6.38±0.40 a
P1×SR2	3	77.66±1.15 a	58.21±2.07 a	14.41±2.49 b	30.89±2.32 a	78.27±0.53 ab	83.07±1.94 a	4.02±0.98 b	6.31±0.40 a
P2×SR1	3	74.22±1.15 ab	51.02±2.07 a	12.37±2.49 ab	23.46±2.32 ab	77.68±0.53 b	78.85±1.94 a	6.48±0.98 ab	5.79±0.40 a
F2×SR2	3	73.64±1.15 b	53.47±2.07 a	15.60±2.49 a	23.63±2.32 ab	79.68±0.53 a	83.16±1.94 a	3.50±0.98 b	6.87±0.40 a
Overall mean	12	74.57±0.58	53.91±1.04	12.65±1.24	24.22±1.16	78.18±0.26	81.48±0.97	5.37±0.49	6.34±0.20

ANOVA

S.O.V	df	F-ratio							
		Whole fish				Flesh			
		Moisture%	Protein%	Fat%	Ash%	Moisture%	Protein%	Fat%	Ash%
Protein level (P)	1	1.251	2.597	1.148	0.341	3.645	0.240	0.606	0.001
Stocking rate(SR)	1	3.499	3.469	4.521	6.886*	9.132**	0.2834	10.871**	1.577
P×SR	1	5.637	0.462	11.73**	6.506*	0.595	0.289	0.060	2.070
Remainder df	8								
Remainder ms		3.98129	12.87556	18.55765	16.10462	0.83405	11.29790	2.86131	0.48206

Means with the same letter in each column are not significantly different.

* P<0.05 ** P<0.01 *** P<0.001