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EFFECT OF DIETARY ENERGY LEVELS, VITAMIN B_5 SUPPLEMENTATION AND STOCKING DENSITY ON NILE TILAPIA (*Oreochromis niloticus*) GROWTH PERFORMANCE

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ABSTRACT: A factorial design (2x3x2) was conducted for studying the effects of dietary energy levels, supplementation levels of vitamin B_5 and stocking density on growth performance traits, chemical body composition and blood components of Nile tilapia. All fish were divided into two main groups. The 1st main group was fed on a diet containing 2900 kcal/kg and the 2nd main group was offered a diet with 3500 kcal/kg. Each main group was divided into 3 sub-groups; the 1st was fed on a diet without supplementation with Pantothenic acid (vitamin B_5), the 2nd and 3rd groups were fed on diets supplemented with 10 and 20 mg Pantothenic acid/ kg diet, respectively. Within each sub-group, the fish divided further into 2 sub-groups; the 1st was stocked at 10 fish/aquarium and the 2nd was stocked at 20 fish/aquarium.

The results revealed the following

1) Live body weight, body weight gain, feed intake and feed conversion of tilapia improved significantly ($P<0.05$ or 0.01) with decreasing dietary energy levels, decreasing stocking density and 10 mg vitamin B_5 supplementation. The interaction effect between vitamin B_5 supplementation and stocking density were significantly ($P<0.01$) only on live body weight, daily body weight gain, daily feed intake and feed conversion. 2) Total protein, albumen, T_3, asparate amino transferase (AST) and alanin amino transferase (ALT) of blood plasma were increased significantly ($P<0.05$ or 0.01) with increasing dietary energy level, increasing stocking density and decreased with 10 mg vitamin B_5 supplementation, however total

plasma protein was decreased with increasing dietary energy level. 3) Decreasing dietary energy level resulted in a significant (P<0.01) increase in dry matter and crud protein but decreased ether extract and ash of tilapia whole body. While these traits did not significantly affected with vitamin B_5 supplementation levels and stocking density. Generally, the Nile tilapia fish growth performance was improved with decreasing each of dietary energy level, stocking density and vitamin B_5 supplementation with level of 10 mg/kg diet, under Egyptian conditions.

Key words: Energy, density, Pantothenic acid, growth performance, blood component, body composition and Nile tilapia.

INTRODUCTION

One of the striking differences in feeds between fish and farm animals is that, the amount of energy required for protein synthesis is much less for fish than for warm blooded animals. Fish have a lower dietary energy requirement because they do not have to maintain a constant body temperature, they exert relatively less energy to maintain position and to move in water, and they lose less energy in protein catabolism and excretion of nitrogenous wastes than land animals because they excrete most of their nitrogenous wastes as ammonia through the gills (Lovell, 1979; NRC, 1983; El-Sayed and Teshima 1992 and NRC, 1993).

A deficiency of Pantothenic acid impairs the metabolism of mitochondria rich cells that undergo rapid mitosis and high energy expenditure. Thus deficiency signs have been found to appear within 10-14 days in rapidly growing fish (Hosokawa, 1989). Clubbed gills, anemia and high mortality have been observed in salmonids (Karges and Woodward, 1984), Channel catfish (Brunson *et al.* 1983 and Wilson *at al.* 1983). Retarded growth, anorexia, lethargy, hemorrhage, skin lesion and anemia were observed in common carp and Japanese eel (Arai *et al.* 1972).

Fish stocking is an important factor in aquaculture as it can affect natural food availability, the efficiency of food resource utilization and total fish yield in ponds. Also, when number of fish stocked in a pond increases the amount of feed available to each fish decreases (Chang 1988 and Delince 1992).

Therefore, this work aimed to study the effects of dietary energy levels, supplementation of vitamin B_5 (Pantothenic acid) and stocking density on growth performance, chemical body composition and blood components of Nile tilapia (*Oreochromis niloticus*).

MATERIALS AND METHODS

The present study was carried out at the Wet. Lab. of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, during the period from July to October, 2005. The experiment lasted 90 days after start.

Fingerlings of Nile tilapia weighing approximately 14 g (after acclamyzation period for three weeks in Wet. Lab.) were obtained from Central Laboratory for Aquaculture Research at Abbassa, Abu-Hammad, Sharkiya governorate Egypt. Fish were adapted to normal laboratory conditions for three weeks. The experimental fish were randomly distributed into 36 glass aquariums (35x40x70 cm), representing to 12 treatments (3 replicates per treatment).

In a factorial design (2x3x2), two main groups of fish were performed. The 1st group was fed on a diet containing 2900 kcal/kg (according to NRC, 1993) and the 2nd group was fed on a diet containing 3500 kcal/kg. Each main group was divided into 3 sub-groups; the 1st was fed on a diet without supplementation with pantothenic acid, the 2nd and 3rd groups were fed on diets supplemented with 10 (according to NRC, 1993) and 20 mg Pantothenic acid/ kg diet, respectively. Within each sub-group, the fish was divided further into 2 other sub-groups; the 1st was stoked at a rate of 10 fish/aquarium and the 2nd was stocked at 20 fish/aquarium rate. Fish in all groups were kept under the same optimum conditions and water quality.

Two practical diets were contained 30% crude protein and 2900 or 3500 kcal/kg (Table 1). The dry ingredients of each diet were grinded through a feed grinder to very small particles sizes. The ingredients were weighed and mixed by mixer to homogeneity. The supplementation of Pantothenic acid is added to ingredients as calcium dl-pantothenate (46%

Table 1. Composition and chemical analysis of the fish diets used (on dry matter basis).

Ingredients	Low energy level (2900 kcal/kg)	High energy level (3500 kcal/kg)
Fish meal (herring)	16.00	16.00
Soya bean meal	10.00	10.00
Yellow corn	24.00	24.00
Corn gluten meal	15.00	16.00
Wheat bran	15.00	6.00
Wheat flour	14.00	13.00
Fish oil	2.00	9.00
Sun flower oil	1.00	3.00
Vitamin mix(1)	1.00	1.00
Minerals mix(2)	2.00	2.00
Total	**100.00**	**100.00**
Chemical analysis:		
Crude protein	29.85	30.21
Ether extract	6.15	17.06
Crude fiber	8.06	6.02
Nitrogen free extract (NFE)	46.14	40.01
Ash	9.80	6.70
Gross energy(kcal/kg)	4159.44	4959.45
Metabolizable energy (ME) (3)	2911.61	3471.62

(1) Each one kg of vitamin mixture contained: Vit. A 72000 IU, Vit.B_1 6 mg, Vit.B_3 12000 IU, Vit.B_6 9 mg , Vit.B_{12} 0.06 mg , Vit. E 60 mg, Vit. K_{12} mg, Pantothenic acid 60 mg, Nicotinic acid 120 mg, Folic acid 6mg , Biotin 0.3 mg and Choline chlorides 3 mg.

(2) Each one kg of Minerals mixture contained: Zinc 1.23 g, Manganese 930 mg, Iron 630 mg , Copper 105 mg , Iodin 10.5 mg, Selnium 2.1mg .

(3) ME was calculated from gross energy as 70% (NRC, 1993).

activity) as a dry powder in a multivitamin premix (NRC, 1993). The oil components (fish and sun flower oil) were gradually added and the mixing operation was continued for 20 minutes. After homogenous mixture, 40 ml water per 100 g diet was slowly added to the mixture according to Shimeino *et al.* (1985). Experimental diets were pellted using the holes meat grinder and dried in drying oven for 24 hours at 65^0C.

Fish were fed the experimental diets 6 days every week at a level of 3% of live body weight during the whole experimental period. Feed amount was adjusted after weighing according the new weight. Fish were weighed to the nearest 0.1 g at the beginning of the experiments and every 15 days and the amount of feed given was adjusted in accordingly on basis of the new biomass. Live body gain was calculated by subtracting the two successive live weights at different experimental periods. The feed conversion ratio (FCR) is expressed as the proportion of dry food required per unit live weight gain of fish according to the following equation:

$$\textbf{FCR} = \frac{\textbf{Feed intake (g)}}{\textbf{Weight gain (g)}}$$

Fish samples were randomly taken from each aquarium for chemical analysis at the start and the end of experimental period. All the samples were prepared for whole body chemical analysis. Samples of the experimental diets and whole fish bodies were analyzed for moisture, total protein, lipids and ash contents according to the methods described by A.O.A.C. (1990).

Blood samples were collected from the caudal vessels (Steucke and Schoettger, 1967) with 2.5cc disposable plastic syringe, previously rinsed with heparin. Blood samples were centrifuged at 3000 rpm for 20 minutes to separate blood plasma. Plasma samples were immediately frozen in copped polyethylene test tubes and stored at -20^0 C to determine total protein, albumen, (Sundeman, 1964), creatinine (Henery 1974), urea-N, thyroxin (T_3), Aspartate amino transferase (AST) and alanine amino transferase (ALT) (Reitman and Fankel, 1957).

Analysis of variance for data was accomplished using the SAS General Linear Models Procedure (SAS, 1996). The effects of energy levels, vitamin B_5 levels and density were statistically analyzed by factorial analysis of variance (2x3x2) according the following statistical model:

$$Y_{ijk} = \mu + E_i + V_j + D_k + EV_{ij} + ED_{ik} + VD_{jk} + EVD_{ijk} + e_{ijk}$$

Where:

Y_{ijk} is an observation, μ is the overall mean, E is the fixed effect of dietary energy level (i=1…2), V is the fixed effect of supplementation of vitamin B_5 (j=1…3), D is the fixed effect of density (k=1…2). EV_{ij} is the interaction effect of dietary energy levels and supplementation of vitamin B_5, ED_{ik} is the interaction effect of dietary energy levels and density, VD_{jk} is the interaction effect of supplementation of vitamin B_5 and EVD_{ijk} is the interaction effect of dietary energy levels, supplementation of vitamin B_5 and stocking density and e_{ijk} is random error.

Means were tested for significant differences by using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth Performance and Feed Utilization

The data illustrated in Table 2 show that the live body weight at the end of the experimental period (90 days), daily body weight gain and daily feed intake during the period 0-90 days were improved significantly ($P<0.01$) with decreasing dietary energy level and stocking density, but the same traits were increased significantly ($P<0.01$) by using vitamin B_5 supplementation. When fish were fed diets supplemented with 10 and 20 mg vitamin B_5 they recorded the highest values in formentioned traits as a compared with the group fed on diets without supplementation. The fish group fed vitamin B_5 supplementation at level 10 mg/kg diet and stocked at normal density were significantly ($P<0.01$) recorded the highest values of live body weight, daily body weight gain and daily feed intake, however the fish group fed diet without vitamin B_5 supplementation and stocked at high density was significantly ($P<0.05$) recorded the lowest formentioned values compared with the other group. Feed conversion ratio was significantly ($P<0.01$) improved with vitamin B_5 supplementation and with decreasing stocking density. Also, all the interactions between vitamin B_5 supplementation and stocking density resulted in a significant ($P<0.05$) improvement in feed conversion ratio except in fish group fed on diets without

Table 2. Live body weight, daily body weight gain, daily feed intake and daily feed conversion of Nile tilapia ($\bar{X} \pm$ SE) as affected by dietary energy levels, vitamin B_5 supplementation, density and their interactions.

Items	Live body weight		Daily body weight gain	Daily feed intake	Daily feed conversion
	Initial	90 days	0-90 days	0-90 days	0-90 days
Energy levels	N.S	**	**	N.S	N.S
Normal energy (E_1)	14.02 ± 0.01	34.78 ± 1.44^a	0.25 ± 0.017^a	0.65 ± 0.018	2.81 ± 0.15
High energy (E_2)	14.00 ± 0.02	34.08 ± 1.43^b	0.24 ± 0.017^b	0.64 ± 0.017	2.90 ± 0.17
Vitamin B_5 supplementation	N.S	**	**	**	**
0.0 mg/kg diet (V_1)	14.01 ± 0.02	26.50 ± 0.40^c	0.15 ± 0.005^c	0.55 ± 0.003^c	3.74 ± 0.10^a
10.0 mg/kg diet (V_2)	14.00 ± 0.02	39.36 ± 0.69^a	0.30 ± 0.008^a	0.71 ± 0.010^a	2.37 ± 0.03^b
20.0 mg/kg diet (V_3)	14.01 ± 0.02	37.43 ± 0.46^b	0.28 ± 0.005^b	0.68 ± 0.007^b	2.44 ± 0.02^b
Density	N.S	**	**	**	**
Normal density (D_1)	14.01 ± 0.02	35.99 ± 1.48^a	0.26 ± 0.018^a	0.67 ± 0.019^a	2.72 ± 0.14^b
High density (D_2)	14.00 ± 0.01	32.87 ± 1.28^b	0.22 ± 0.015^b	0.63 ± 0.015^b	2.99 ± 0.18^a
Interaction between E&V	N.S	N.S	N.S	N.S	N.S
$E_1 V_1$	14.04 ± 0.02	26.83 ± 0.53	0.15 ± 0.006	0.55 ± 0.005	3.65 ± 0.14
$E_1 V_2$	13.98 ± 0.02	39.78 ± 1.04	0.31 ± 0.012	0.72 ± 0.015	2.35 ± 0.05
$E_1 V_3$	14.02 ± 0.02	37.74 ± 0.69	0.28 ± 0.008	0.68 ± 0.011	2.43 ± 0.04
$E_2 V_1$	13.98 ± 0.03	26.17 ± 0.61	0.15 ± 0.007	0.55 ± 0.005	3.83 ± 0.16
$E_2 V_2$	14.02 ± 0.03	38.94 ± 0.96	0.30 ± 0.011	0.71 ± 0.015	2.40 ± 0.04
$E_2 V_3$	14.00 ± 0.02	37.12 ± 0.63	0.28 ± 0.008	0.68 ± 0.010	2.46 ± 0.03
Interaction between E&D	N.S	N.S	N.S	N.S	N.S
$E_1 D_1$	14.02 ± 0.02	36.29 ± 2.24	0.27 ± 0.027	0.67 ± 0.029	2.70 ± 0.21
$E_1 D_2$	14.01 ± 0.01	33.27 ± 1.81	0.23 ± 0.022	0.63 ± 0.022	2.91 ± 0.23
$E_2 D_1$	14.00 ± 0.03	35.69 ± 2.08	0.26 ± 0.025	0.67 ± 0.027	2.73 ± 0.19
$E_2 D_2$	14.00 ± 0.02	32.46 ± 1.92	0.22 ± 0.023	0.62 ± 0.021	3.07 ± 0.28
Interaction between V&D	N.S	**	**	**	*
V1 D1	14.01 ± 0.04	27.52 ± 0.21^e	0.16 ± 0.003^e	0.56 ± 0.002^e	3.50 ± 0.05^b
V1 D2	14.01 ± 0.02	25.48 ± 0.49^f	0.14 ± 0.006^f	0.54 ± 0.001^f	3.98 ± 0.15^a
V2 D1	14.00 ± 0.04	41.58 ± 0.29^a	0.33 ± 0.004^a	0.75 ± 0.003^a	2.28 ± 0.02^d
V2 D2	14.00 ± 0.02	37.14 ± 0.18^c	0.28 ± 0.002^c	0.68 ± 0.002^c	2.47 ± 0.01^{cd}
V3 D1	14.02 ± 0.03	38.88 ± 0.22^b	0.30 ± 0.003^b	0.70 ± 0.003^b	2.37 ± 0.02^{cd}
V3 D2	14.00 ± 0.02	35.98 ± 0.16^d	0.26 ± 0.002^d	0.66 ± 0.002^d	2.51 ± 0.01^c
Interaction between E&V&D	N.S	N.S	N.S	N.S	N.S
E1 V1 D1	14.07 ± 0.03	27.51 ± 0.41	0.16 ± 0.005	0.56 ± 0.003	3.52 ± 0.10
E1 V1 D2	14.02 ± 0.02	26.14 ± 0.87	0.14 ± 0.010	0.54 ± 0.001	3.78 ± 0.26
E1 V2 D1	13.97 ± 0.03	42.11 ± 0.22	0.34 ± 0.003	0.75 ± 0.006	2.24 ± 0.01
E1 V2 D2	14.00 ± 0.03	37.46 ± 0.04	0.28 ± 0.001	0.68 ± 0.001	2.45 ± 0.01
E1 V3 D1	14.03 ± 0.03	39.26 ± 0.23	0.30 ± 0.003	0.71 ± 0.003	2.36 ± 0.03
E1 V3 D2	14.01 ± 0.02	36.21 ± 0.10	0.26 ± 0.001	0.66 ± 0.002	2.50 ± 0.01
E2 V1 D1	13.95 ± 0.05	27.52 ± 0.24	0.16 ± 0.003	0.56 ± 0.002	3.49 ± 0.06
E2 V1 D2	14.00 ± 0.03	24.82 ± 0.07	0.13 ± 0.001	0.54 ± 0.001	4.18 ± 0.03
E2 V2 D1	14.03 ± 0.07	41.05 ± 0.29	0.32 ± 0.004	0.74 ± 0.002	2.31 ± 0.03
E2 V2 D2	14.00 ± 0.03	36.82 ± 0.25	0.27 ± 0.003	0.68 ± 0.002	2.49 ± 0.02
E2 V3 D1	14.01 ± 0.04	38.49 ± 0.23	0.29 ± 0.003	0.70 ± 0.001	2.39 ± 0.02
E2 V3 D2	13.99 ± 0.03	35.75 ± 0.25	0.26 ± 0.003	0.65 ± 0.003	2.52 ± 0.02

Means in the same column within each classification bearing different letters are significantly ($P \leq 0.05$) different.

vitamin B_5 supplementation and stocked at high density (Table 2). These results may be indicated that vitamin B_5 (Pantothenic acid) serves as a precursor for coenzyme A (CoA) which is essential for the metabolism of the major dietary nutrients such as carbohydrate, lipid and protein (NRC, 1993). This metabolic role of vitamin B_5 may explain the improvement in growth and feed utilization of the fish fed diet supplemented with vitamin B_5.

The obtained results were similar to those reported by Ibrahim (2000) who found that the increase in dietary energy and stocking density decreased growth performance. Similar results were reported by Sweilum *et al.* (2005) who found that final body weight and weight gain were significantly ($P<0.05$) increased with decreasing energy level (10.5 kJ/g). Soliman and Wilson (1992) found that feed utilization increased stepwise up to dietary level of 10 mg Ca d-pantothenate/kg diet. Sayed (2002) found that reduced food consumption was evidenced by the low feed efficiency value for fish fed the Pantothenic acid free diet.

Blood Components

The data illustrated in Table 3 show that the increasing of dietary energy level significantly ($P<0.05$ or 0.01) decreased total plasma protein and globulin, respectively and significantly ($P<0.01$) increased T_3. The high level of vitamin B_5 supplementation or low stocking density significantly ($P<0.01$) decreased total protein, albumin, globulin and T_3 whereas the lowest value was observed with diet supplemented 10 mg vitamin B_5. The interaction between dietary energy level and vitamin B_5 supplementation significantly ($P<0.01$) affected total protein, albumin, globulin and T_3 in blood plasma whereas, the increasing of energy level and vitamin B_5 supplementation resulted in decreased of globulin and T_3 .The interaction between dietary energy and vitamin B_5 supplementation significantly ($P<0.01$) affected only globulin and T_3. Total protein, albumin and globulin were significantly ($P<0.01$) affected with the interaction between vitamin B_5 supplementation and stocking density. The interaction between dietary energy, vitamin B_5 supplementation and stocking density was significantly ($P<0.01$) affected total protein, albumin and T_3.

The urea-N and ALT were significantly ($P<0.01$) increased

Table 3. Blood components of Nile tilapia ($\bar{X} \pm$ SE) as affected by energy levels, vitamin B_5 supplementation, density and their interactions.

Items	Total protein (g/100ml)	Albumin (g/100ml)	Globulin (g/100ml)	T3 (ng/ml)
Energy levels	*	N.S	**	**
Normal energy (E_1)	5.28 ± 0.17^a	3.28 ± 0.12	2.00 ± 0.13^a	2.77 ± 0.13^b
High energy (E_2)	5.06 ± 0.13^b	3.34 ± 0.09	1.73 ± 0.11^b	2.96 ± 0.12^a
Vitamin B_5 supplementation	**	**	**	**
0.0 mg/kg diet (V_1)	5.48 ± 0.22^a	3.49 ± 0.05^a	2.00 ± 0.20^b	3.02 ± 0.15^a
10.0 mg/kg diet (V_2)	4.74 ± 0.10^b	3.25 ± 0.11^b	1.49 ± 0.08^c	2.62 ± 0.14^b
20.0 mg/kg diet (V_3)	5.30 ± 0.16^a	3.19 ± 0.17^b	2.12 ± 0.07^a	2.97 ± 0.15^a
Density	**	**	N.S	**
Normal density (D_1)	4.96 ± 0.12^b	3.10 ± 0.12^b	1.85 ± 0.10	2.75 ± 0.13^b
High density (D_2)	5.39 ± 0.17^a	3.51 ± 0.05^a	1.88 ± 0.14	2.99 ± 0.12^a
Interaction between E&V	**	**	**	**
$E_1 V_1$	5.94 ± 0.27^a	3.44 ± 0.06^{ab}	2.49 ± 0.21^a	3.46 ± 0.08^a
$E_1 V_2$	4.92 ± 0.17^b	3.45 ± 0.14^{ab}	1.48 ± 0.06^c	2.36 ± 0.10^c
$E_1 V_3$	4.99 ± 0.25^b	2.95 ± 0.31^b	2.04 ± 0.10^b	2.49 ± 0.09^{bc}
$E_2 V_1$	5.03 ± 0.24^b	3.53 ± 0.09^a	1.50 ± 0.16^c	2.58 ± 0.12^{bc}
$E_2 V_2$	4.55 ± 0.08^b	3.06 ± 0.16^{ab}	1.49 ± 0.16^c	2.87 ± 0.22^b
$E_2 V_3$	5.62 ± 0.09^a	3.43 ± 0.13^{ab}	2.19 ± 0.10^{ab}	3.45 ± 0.08^a
Interaction between E&D	N.S	N.S	**	**
$E_1 D_1$	5.03 ± 0.16	3.12 ± 0.22	1.91 ± 0.11^b	2.76 ± 0.18^b
$E_1 D_2$	5.54 ± 0.28	3.44 ± 0.08	2.10 ± 0.23^a	2.78 ± 0.20^b
$E_2 D_1$	4.88 ± 0.18	3.09 ± 0.10	1.79 ± 0.18^c	2.73 ± 0.19^b
$E_2 D_2$	5.25 ± 0.19	3.59 ± 0.07	1.66 ± 0.14^d	3.19 ± 0.10^a
Interaction between V&D	**	**	**	N.S
$V_1 D_1$	4.94 ± 0.20^b	3.34 ± 0.04^a	1.60 ± 0.20^{cd}	2.88 ± 0.25
$V_1 D_2$	6.03 ± 0.23^a	3.63 ± 0.06^a	2.39 ± 0.26^a	3.16 ± 0.16
$V_2 D_1$	4.91 ± 0.18^b	2.24 ± 0.23^a	1.67 ± 0.09^{cd}	2.47 ± 0.09
$V_2 D_2$	4.56 ± 0.07^b	3.26 ± 0.06^a	1.30 ± 0.08^d	2.76 ± 0.26
$V_3 D_1$	5.02 ± 0.26^b	2.73 ± 0.21^b	2.29 ± 0.07^{ab}	2.91 ± 0.27
$V_3 D_2$	5.59 ± 0.10^a	3.65 ± 0.05^a	1.94 ± 0.06^{bc}	3.03 ± 0.18
Interaction between E&V&D	**	**	N.S	**
$E_1 V_1 D_1$	5.36 ± 0.12^b	3.34 ± 0.06^{bc}	2.03 ± 0.07	3.42 ± 0.14^a
$E_1 V_1 D_2$	6.51 ± 0.14^a	3.55 ± 0.05^{ab}	2.96 ± 0.10	3.51 ± 0.09^a
$E_1 V_2 D_1$	5.24 ± 0.16^b	3.74 ± 0.60^a	1.51 ± 0.10	2.53 ± 0.14^{bcd}
$E_1 V_2 D_2$	4.60 ± 0.12^c	3.15 ± 0.06^c	1.45 ± 0.07	2.19 ± 0.08^d
$E_1 V_3 D_1$	4.48 ± 0.19^c	2.28 ± 0.09^e	2.21 ± 0.10	2.35 ± 0.12^{cd}
$E_1 V_3 D_2$	5.50 ± 0.18^b	3.62 ± 0.09^a	1.88 ± 0.12	2.64 ± 0.08^{bc}
$E_2 V_1 D_1$	4.51 ± 0.07^c	3.34 ± 0.06^{bc}	1.17 ± 0.02	2.33 ± 0.07^{cd}
$E_2 V_1 D_2$	5.54 ± 0.07^b	3.71 ± 0.09^a	1.83 ± 0.10	2.82 ± 0.09^b
$E_2 V_2 D_1$	4.58 ± 0.15^c	2.75 ± 0.15^d	1.83 ± 0.03	2.40 ± 0.13^{cd}
$E_2 V_2 D_2$	4.52 ± 0.08^c	3.36 ± 0.05^{bc}	1.15 ± 0.08	3.33 ± 0.08^a
$E_2 V_3 D_1$	5.56 ± 0.15^b	3.18 ± 0.10^c	2.38 ± 0.08	3.47 ± 0.16^a
$E_2 V_3 D_2$	5.68 ± 0.12^b	3.68 ± 0.08^a	2.00 ± 0.05	3.42 ± 0.07^a

Means in the same column within each classification bearing different letters are significantly ($P \leq 0.05$) different.

Table 3. Continued.

Items	Urea-N (mg/100ml)	Creatinine (mg/100ml)	AST (U/L)	ALT (U/L)
Energy levels	**	N.S	N.S	**
Normal energy (E_1)	09.71 ± 0.28[b]	1.22 ± 0.02	26.15 ± 1.04	13.41 ± 0.46[b]
High energy (E_2)	10.30 ± 0.29[a]	1.23 ± 0.03	26.79 ± 1.09	14.23 ± 0.73[a]
Vitamin B_5 supplementation	**	N.S	**	**
0.0 mg/kg diet (V_1)	09.78 ± 0.43[b]	1.21 ± 0.02	27.86 ± 1.01[a]	14.94 ± 0.48[a]
10.0 mg/kg diet (V_2)	09.77 ± 0.34[b]	1.23 ± 0.04	23.51 ± 1.00[b]	12.20 ± 0.64[c]
20.0 mg/kg diet (V_3)	10.39 ± 0.27[a]	1.24 ± 0.04	28.03 ± 1.45[a]	14.33 ± 0.87[b]
Density	**	N.S	**	**
Normal density (D_1)	10.30 ± 0.33[a]	1.21 ± 0.03	23.39 ± 0.62[b]	12.33 ± 0.40[b]
High density (D_2)	09.72 ± 0.22[b]	1.24 ± 0.03	29.55 ± 0.89[a]	15.32 ± 0.58[a]
Interaction between E&V	**	N.S	**	**
E_1 V_1	09.28 ± 0.25[c]	1.18 ± 0.02	26.19 ± 1.23[ab]	13.68 ± 0.26[abc]
E_1 V_2	09.27 ± 0.49[c]	1.23 ± 0.06	25.45 ± 1.62[ab]	13.33 ± 1.12[bc]
E_1 V_3	10.59 ± 0.50[a]	1.26 ± 0.04	26.79 ± 2.60[a]	13.24 ± 0.90[bc]
E_2 V_1	10.47 ± 0.77[a]	1.24 ± 0.04	29.54 ± 1.35[a]	16.21 ± 0.55[a]
E_2 V_2	10.27 ± 0.41[ab]	1.22 ± 0.07	21.57 ± 0.53[b]	11.07 ± 0.17[c]
E_2 V_3	10.19 ± 0.23[b]	1.22 ± 0.06	29.27 ± 1.36[a]	15.43 ± 1.42[ab]
Interaction between E&D	*	N.S	**	N.S
E_1 D_1	09.88 ± 0.51[b]	1.21 ± 0.04	22.19 ± 0.49[b]	11.83 ± 0.42
E_1 D_2	09.54 ± 0.24[b]	1.23 ± 0.03	30.10 ± 0.69[a]	15.00 ± 0.29
E_2 D_1	10.72 ± 0.41[a]	1.22 ± 0.05	24.59 ± 1.02[b]	12.82 ± 0.66
E_2 D_2	09.89 ± 0.36[b]	1.24 ± 0.05	28.99 ± 1.68[a]	15.64 ± 1.15
Interaction between V&D	**	**	**	**
V_1 D_1	10.99 ± 0.54[a]	1.21 ± 0.03[b]	25.12 ± 0.83[b]	14.28 ± 0.51[bc]
V_1 D_2	08.76 ± 0.13[b]	1.21 ± 0.03[b]	30.61 ± 0.88[a]	15.60 ± 0.75[ab]
V_2 D_1	08.79 ± 0.27[b]	1.10 ± 0.03[c]	21.32 ± 0.49[c]	10.91 ± 0.18[e]
V_2 D_2	10.75 ± 0.23[a]	1.35 ± 0.03[a]	25.70 ± 1.51[b]	13.49 ± 1.04[cd]
V_3 D_1	11.14 ± 0.29[a]	1.34 ± 0.04[a]	23.74 ± 1.23[c]	11.80 ± 0.35[de]
V_3 D_2	09.64 ± 0.09[b]	1.14 ± 0.03[bc]	32.33 ± 0.57[a]	16.87 ± 0.77[a]
Interaction between E&V&D	**	N.S	**	**
E_1 V_1 D_1	09.80 ± 0.14[ef]	1.18 ± 0.04	23.56 ± 0.71[d]	13.37 ± 0.47[cd]
E_1 V_1 D_2	08.76 ± 0.12[g]	1.18 ± 0.01	28.82 ± 0.44[b]	14.00 ± 0.08[d]
E_1 V_2 D_1	08.20 ± 0.05[g]	1.13 ± 0.05	21.98 ± 0.80[e]	10.87 ± 0.32[g]
E_1 V_2 D_2	10.34 ± 0.24[de]	1.33 ± 0.05	28.93 ± 0.67[b]	15.78 ± 0.33[c]
E_1 V_3 D_1	11.65 ± 0.31[ab]	1.33 ± 0.05	21.04 ± 0.35[e]	11.27 ± 0.20[fg]
E_1 V_3 D_2	09.53 ± 0.08[f]	1.19 ± 0.02	32.55 ± 0.77[a]	15.22 ± 0.26[c]
E_2 V_1 D_1	12.17 ± 0.10[a]	1.24 ± 0.06	26.67 ± 0.71[c]	15.20 ± 0.49[c]
E_2 V_1 D_2	08.76 ± 0.23[g]	1.24 ± 0.06	32.40 ± 0.68[a]	17.21 ± 0.51[b]
E_2 V_2 D_1	09.35 ± 0.15[f]	1.07 ± 0.01	20.67 ± 0.35[e]	10.94 ± 0.23[g]
E_2 V_2 D_2	11.15 ± 0.20[bc]	1.37 ± 0.05	22.46 ± 0.71[de]	11.20 ± 0.28[fg]
E_2 V_3 D_1	10.62 ± 0.23[cd]	1.34 ± 0.07	26.44 ± 0.43[c]	12.33 ± 0.54[ef]
E_2 V_3 D_2	09.75 ± 0.15[f]	1.10 ± 0.03	32.11 ± 1.00[a]	18.52 ± 0.44[a]

Means in the same column within each classification bearing different letters are significantly ($P \leq 0.05$) different.

with increasing dietary energy level which may indicate that the kidney and liver functions increased with increasing dietary energy levels. Vitamin B_5 supplementation affected significantly (P<0.01) urea-N, AST and ALT whereas the lowest values was recorded with 10 mg vitamin B_5/ kg diet. While, the high stocking density significantly (P<0.01) decreased urea-N and significantly (P<0.01) increased AST and ALT which may due to crowding effect. Urea-N, AST and ALT were significantly (P<0.01) affected with the interaction between dietary energy level and vitamin B_5 supplementation and interaction between dietary energy levels, vitamin B_5 supplementation and stocking density. The interaction between dietary energy levels and stocking density affected significantly (P<0.05 or 0.01) both urea-N and AST, respectively. Moreover, urea-N, creatinine, AST and ALT were significantly (P<0.01) affected with the interaction between vitamin B_5 supplementation and stocking density, whereas the lowest values were significantly (P<0.01) recorded in fish group fed the diet with 10 mg vitamin B_5/ kg diet and stocked at low density (Table 3).

Whole Body Composition

The results tabulated in Table 4 show that the dry matter and crude protein percentages were significantly (P<0.01) decreased only with increasing dietary energy level while, the ash percentage significantly (P<0.01) increased with increasing dietary energy level. However, the same traits were insignificantly affected by vitamin B_5 supplementation or stocking density. The interaction between dietary energy, vitamin B_5 supplementation and stocking density significantly (P<0.05) released an effect only on ash percentage whereas the highest value was recorded in fish group fed diet containing high energy level, 10 mg vitamin B_5 and stocked at high density while, the lowest value was observed in fish group fed on a diet with normal energy level, 20 mg vitamin B_5 and stocked at low density. There were no significant differences in ether extract percentage but it was higher (16.49%) in fish fed high dietary energy than low. These results showed that tilapia were able to store significant quantities of lipids in carcass and viscera, but were not able to utilize the energy sources to improve growth or feed conversion efficiency (Hanley 1991).

Table 4. Whole body composition (%) of Nile tilapia ($\bar{X}$ ±SE) as affected by energy levels, vitamin B_5 supplementation, density and their interactions.

Items	Dry matter	Crud protein	Ether extract	Ash
	$\bar{X}$ ± SE	$\bar{X}$ ± SE	$\bar{X}$ ± SE	$\bar{X}$ ± SE
Energy levels	**	**	N.S	**
Normal energy (E_1)	23.08 ± 0.56^a	65.06 ± 0.11^a	15.55 ± 0.19	17.03 ± 0.12^b
High energy (E_2)	21.28 ± 0.39^b	63.38 ± 0.36^b	16.49 ± 0.38	17.78 ± 0.17^a
Vitamin B_5 supplementation	N.S	N.S	N.S	N.S
0.0 mg/kg diet (V_1)	22.32 ± 0.73	64.03 ± 0.39	16.27 ± 0.27	17.60 ± 0.15
10.0 mg/kg diet (V_2)	21.97 ± 0.71	64.44 ± 0.46	15.75 ± 0.51	17.31 ± 0.23
20.0 mg/kg diet (V_3)	22.25 ± 0.51	64.19 ± 0.38	16.03 ± 0.36	17.31 ± 0.23
Density	N.S	N.S	N.S	N.S
Normal density (D_1)	22.21 ± 0.37	64.44 ± 0.27	15.84 ± 0.20	17.27 ± 0.18
High density (D_2)	22.15 ± 0.65	63.99 ± 0.38	16.20 ± 0.40	17.54 ± 0.16
Interaction between E&V	N.S	N.S	N.S	N.S
E_1 V_1	23.96 ± 0.95	65.03 ± 0.18	15.82 ± 0.19	17.37 ± 0.10
E_1 V_2	22.98 ± 0.29	65.14 ± 0.24	15.47 ± 0.41	17.01 ± 0.11
E_1 V_3	22.31 ± 0.56	64.99 ± 0.17	15.34 ± 0.36	16.70 ± 0.26
E_2 V_1	20.68 ± 0.60	63.02 ± 0.47	16.73 ± 0.44	17.82 ± 0.26
E_2 V_2	20.95 ± 0.38	63.39 ± 0.83	16.02 ± 0.98	17.60 ± 0.44
E_2 V_3	22.20 ± 0.90	63.38 ± 0.60	16.72 ± 0.49	17.93 ± 0.15
Interaction between E&D	N.S	N.S	N.S	N.S
E_1 D_1	22.84 ± 0.37	65.35 ± 0.11	15.39 ± 0.24	16.89 ± 0.12
E_1 D_2	23.32 ±1.08	64.76 ± 0.13	15.70 ± 0.30	17.16 ± 0.19
E_2 D_1	21.58 ± 0.59	63.54 ± 0.30	16.29 ± 0.24	17.65 ± 0.29
E_2 D_2	20.98 ± 0.53	63.22 ± 0.67	16.70 ± 0.73	17.92 ± 0.19
Interaction between V&D	N.S	N.S	N.S	N.S
V_1 D_1	22.26 ± 0.50	64.27 ± 0.56	15.97 ± 0.21	17.62 ± 0.28
V_1 D_2	22.38 ± 1.44	63.78 ± 0.56	16.58 ± 0.48	17.58 ± 0.14
V_2 D_1	21.77 ± 0.69	64.62 ± 0.47	15.51 ± 0.35	16.91 ± 0.26
V_2 D_2	22.16 ± 1.31	64.26 ± 0.84	15.99 ± 1.00	17.71 ± 0.33
V_3 D_1	22.59 ± 0.78	64.44 ± 0.44	16.03 ± 0.43	17.29 ± 0.35
V_3 D_2	21.91 ± 0.69	63.94 ± 0.65	16.03 ± 0.61	17.39 ± 0.34
Interaction between E&V&D	N.S	N.S	N.S	*
E_1 V_1 D_1	23.24 ± 0.43	65.31 ± 0.22	15.68 ± 0.10	17.15 ± 0.05^{cdb}
E_1 V_1 D_2	24.67 ± 1.94	64.75 ± 0.19	15.96 ± 0.10	17.58 ± 0.06^{abcd}
E_1 V_2 D_1	22.61 ± 1.10	65.42 ± 0.31	15.04 ± 0.10	16.96 ± 0.21^{cd}
E_1 V_2 D_2	23.35 ± 2.63	64.86 ± 0.35	15.91 ± 0.10	17.06 ± 0.12^{cdb}
E_1 V_3 D_1	22.66 ± 0.35	65.31 ± 0.06	15.45 ± 0.10	16.56 ± 0.21^{d}
E_1 V_3 D_2	21.95 ± 1.15	64.68 ± 0.22	15.24 ± 0.10	16.84 ± 0.52^{cd}
E_2 V_1 D_1	21.28 ± 0.37	63.23 ± 0.66	16.27 ± 0.10	18.08 ± 0.43^{ab}
E_2 V_1 D_2	20.08 ± 1.13	62.81 ± 0.78	17.19 ± 0.10	17.57 ± 0.30^{abcd}
E_2 V_2 D_1	20.93 ± 0.69	63.82 ± 0.62	15.97 ± 0.10	16.86 ± 0.54^{cd}
E_2 V_2 D_2	20.97 ± 0.48	63.66 ± 1.75	16.07 ± 0.10	18.35 ± 0.32^{a}
E_2 V_3 D_1	22.53 ± 1.71	63.57 ± 0.45	16.61 ± 0.10	18.02 ± 0.18^{ab}
E_2 V_3 D_2	21.88 ± 1.03	63.20 ± 1.24	16.83 ± 0.10	17.84 ± 0.26^{bc}

Means in the same column within each classification bearing different letters are significantly ($P \leq 0.05$) different.

In general, the highest value of dry matter (24.67 %), crude protein (65.42%) and ether extract (17.19%) were observed for fish group fed normal energy, without vitamin B_5 supplementation, high stocking density; or fish group fed on diets normal energy, 10 mg vitamin B_5, low stocking density and the other group fed high energy, without vitamin B_5 and stocked at high density, respectively, (Table 4).

Similar results were reported by Amanat *et al* (2000) who found that the fish fed on diets containing lipids recorded higher ($P<0.05$) body fat compared with those fed the lipid-free diet. Also, Sweilum *et al.* (2005) found that body protein increased with decreasing energy while lipid increased with highest energy. Further more Soliman and Wilson (1992) who found that the body composition of Nile tilapia fish was less affected by dietary pantothenic acid with no differences in ash, crude protein and lipid of fish. Also, El-Sayed (2002) and Azim *at al.* (2003) reported that body composition was not significantly affected by stocking density.

In conclusion, the Nile tilapia fish growth performance was improved with decreasing each of dietary energy level, stocking density and vitamin B_5 supplementation with level of 10 mg/kg diet, under Egyptian conditions.

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تأثير مستويات من الطاقة وإضافة فيتامين B_5 ومعدلات التسكين على أداء النمو في أسماك البلطي النيلي

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أجريت هذه الدراسة بمعمل الأسماك بقسم الإنتاج الحيواني – كلية الزراعة – جامعة الزقازيق – الزقازيق – مصر – خلال الفترة من يوليو إلي أكتوبر ٢٠٠٥. وقد استهدفت الدراسة تحديد تأثير مستويات مختلفة من الطاقة وإضافة فيتامين B_5 والكثافة في وحدة الحجم علي معدل النمو ومكونات الجسم والدم في أسماك البلطي النيلي. وقد تم تقسيم الأسماك (تصميم عاملي ٢×٣×٢) إلي مجموعتين حسب مستوى الطاقة (٢٩٠٠ ، ٣٥٠٠ كيلو كالورى/كجم) وتحت كل مجموعة تم إضافة ٣ مستويات من فيتامين B_5 (صفر ، ١٠ ، ٢٠ ملجم/كجم علف) وتحت كل مستوي مستويين من الكثافة (١٠ ، ٢٠ سمكة/حوض).

و كانت أهم النتائج المتحصل عليها:

١– انخفض كلا من وزن الجسم ومعدل النمو ومعدل التحويل الغذائي بزيادة مستوي الطاقة وزيادة الكثافة، بينما تحسنت جميعها بإضافة فيتامين B_5 حيث كان أفضلها مع المستوي ١٠ ثم ٢٠ ملجم. لم تتأثر تلك الصفات معنويا بجميع التداخلات بين كلا من الطاقة وفيتامين B_5 والكثافة فيما عدا التداخل الثنائي بين فيتامين B_5 والكثافة حيث أدى إلي تحسين كل هذه الصفات.

٢– انخفض كلا من البروتين الكلي والجلوبيولين في بلازما الدم معنويا بزيادة مستوى الطاقة بينما زادت إنزيمات الكبد (AST & ALT). أدت زيادة الفيتامين إلي زيادة اليوريا وAST والجلوبيولين بينما انخفض الألبيومين معنويا. زاد كلا من البروتين الكلي والألبيومين و T_3 و AST وALT معنويا بزيادة الكثافة بينما انخفضت اليوريا معنويا. تأثر كلا من البروتين الكلي والألبيومين و T_3 واليوريا و AST وALT معنويا بالتداخل الثلاثي بين الطاقة وفيتامين B_5 والكثافة.

٣– أدت زيادة الطاقة إلي انخفاض كلا من المادة الجافة والبروتين الخام معنويا وزيادة الرماد والدهن في الجسم، بينما لم تتأثر جميع مكونات الجسم معنويا بكلا من فيتامين B_5 والكثافة وكذا التداخلات بين الطاقة وفيتامين B_5 والكثافة فيما عدا أن الرماد تأثر معنويا بالتداخل الثلاثي بين الطاقة وفيتامين B_5 والكثافة.

وتبين نتائج هذه الدراسة أن أداء النمو لأسماك البلطي النيلي قد تحسن بانخفاض كلا من الطاقة (٢٩٠٠ كيلو كالورى/كجم) وإضافة فيتامين B_5 بمستوى ١٠ ملجم/كجم علف والكثافة المعتدلة (١٠ سمكات/حوض) تحت الظروف المصرية.