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EFFECT OF DIETARY SUPPLEMENTATION OF BETAINE AND/OR STOCKING DENSITY ON PERFORMANCE OF NILE TILAPIA

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ABSTRACT

In the present work, feeding *O. niloticus* fish on diets containing different levels of betaine (0.0, 0.5 and 1.0%) and stocked at three densities (2, 3 and 4 g fish / liter) led to some results which could be summarized in the following points. The results clearly showed that the diets containing (1% and 0.5% betaine) were slightly better in all the tested parameters than the control, but on the other hand the results clearly showed that the fish stocked at 2g fish / l and 3g fish / l were slightly better in average weight gain, average daily gain, specific growth rate, relative growth rate, and survival rate than the control. Increasing dietary betaine level caused significant increases in the growth rates (RGR and SGR) and consumption of feed and protein, but feed conversion efficiency decreased significantly. Elevated stocking density of fish led to significantly lower growth rates and protein intake**;** yet, the feed conversion improved significantly. Dietary protein utilization (PER and PPV) was improved significantly by raising the dietary betaine level, but the survival rate was not affected. Raising the stocking density of the experimented fish resulted in significant decreases of dietary protein utilization, although the survival rate was not influenced. Concerning whole fish body composition, percentages of DM and CP (and to some extent also ash) increased, but EE% decreased by elevating the betaine level. Increasing stocking rate of fish was responsible for increased % of DM, leading to increases in CP and ash, but EE percentages of the whole fish body decreased. Elevating dietary betaine level led to increasing feed intake and feed cost, but increasing fish weight gain compensated this input items, so led to lower feeding costs for producing one-kilogram fish weight gain. This means that dietary inclusion of betaine improves piscicultue economy. From the foregoing results it could be concluded that the addition of 1.0% of betaine in the diets of Nile tilapia stocked at 2g fish/l is useful to enhance the fish growth and production economy.

Keywords: Nile tilapia **–** Betaine **–** Stocking density – Performance.

INTRODUCTION

Nile tilapia *O. niloticus*, are considered as the most common and popular fish in Egypt, and has proved to be of great importance. However, Khouraiba (1997) reported that tilapias are constantly gaining importance in aquaculture, especially in the tropics and subtropics. In Egypt, tilapias constitute approximately 45% of inland water fishery production. Nutrition is the most important factor of the culture process; it is often represent the major operating cost of aquaculture. It is advisable for aquaculturist to know the optimum quality and quantity of feeds introduced to fish to avoid poor growth, health and reproduction (Landau, 1992). Deficiency of some of these components causes a depression in growth of fish and may lead to diseases

(Magouz, 1990). Optimal feeding regimes may result in reduced feed costs by minimizing expenditure of metabolic rate of fish. Attractive feed may be consumed quickly, thus reducing losses by leaching of essential water-soluble components. An addition of chemo-attractants to pelletized feeds may increase ingestion rates and improve growth, survival and food conversion (El-Sayed *et al.,* 2005). Individual amino acids and betaine are the most effective feeding stimulants in various crustaceans' feeds. Betaine is also a flavor additive in diets or rearing water of some crustaceans and fish species. It is a naturally occurring substance found in a wide variety of plant and animal species. The osmo - protective properties of betaine are based on its ability to increase intracellular osmotic strength, to replace inorganic ions in this function and protect enzymes from osmotic inactivation. It also reduces mortality and enhances growth performance. Betaine is an oxidized form of choline (a vitamin like nutrient), which is an important component of the phospholipid lecithin and certain other complex lipids. Choline serves as a source of labile methyl groups for the synthesis of various methiolated metabolites and as a precursor of acetylcholine. There may be an interaction between dietary choline, betaine and essential amino acid methionine. It appears that betaine spares the choline requirements in juvenile fish (Kasper *et al*., 2002 and Magouz, 2002a). Stocking density affects the yield form of an aquaculture site. Since increasing stocking density increase problems with water quality and yield of fish (Khouraiba, 1989). On the other hand, optimum returns on capital and labor depended upon using the highest possible stocking densities which are consistent with good survival and growth. The objective of this study was to determine if betaine is a flavor additive in tilapia diets and to investigate its effects on growth performance and reducing environmental stress in semi-intensive production system of tilapia fingerlings.

MATERIALS AND METHODS

The present works was carried out at the wet lab of the Department of Animal and Fish Production, Faculty of Agriculture, Kafr El-Sheikh University during year 2005. Feeding experiment was conducted to study the effect of dietary graded levels of betaine on growth performance, carcass composition and feed utilization of Nile tilapia, *Oreochromios niloticus,* fingerlings for 15 weeks at 3 stocking densities. The experimental system consisted of 27 glass aquaria (60×35×40cm), each aquarium was continuously supplied with a compressed air from an electric compressor. Dechlorinated tap water was used to change one third of the water in each aquarium every day. Water was aerated before be used for about 24 hours to remove chlorine.

Experimental fish:

A group of Nile tilapia (*O. niloticus*) with an average initial body weigh of about 20g was stocked at three densities, being 2, 3 and 4 g fish / liter. Fish were obtained from the stock of earthen ponds (from a private farm in Hamoul, Kafr El-Sheikh Governorate) and transported into the aquaria located at the fish researchs laboratory of Faculty of Agriculture, Kafr El-

Sheikh Governorate. The fish were maintained in these aquaria for 2 weeks before the beginning of the experiment for the acclimatization purpose. The fish were fed during the acclimatization period on a basal diet at a daily rate of 3% of the body weight, at 2 times daily. The experimental treatments were tested at three aquaria (replicates) for each**.**

Experimental diet:

A basal diet (28% crude protein) was formulated from the memorial ingredients (fish meal, soybean meal, yellow corn, wheat bran, sunflower oil, vit. & min. and betaine). Betafin® (betaine) was bought from the local distributor of the product produced by Dansico Animal Nut., Finland. However, the ingredients of the experimental diet were bought from the local market. These ingredients were pressed by manufacturing machine (pellets size was 3 mm). The basal diet No.1 was considered as a control. Composition and chemical analysis of the basal and experimental diets are presented in Table (1).

Table (1): Composition (%) and chemical analysis (% dry matter bases) of the experimental diets.

Ingredients	Diet No. 1 %	Diet No. 2 %	Diet No. 3 %
Fish meal	10	10	10
Soybean meal	40	40	40
Yellow corn	32.7	32.2	31.7
Wheat bran	10	10	10
Sunflower oil	5	5	5
Dicalcium phosphate	2	2	2
Vitamins & minerals*	0.3	0.3	0.3
Betaine	0.0	0.5	1.0
Chemical analysis			
Dry matter (DM)	89.56	89.42	89.33
Crude protein (CP)	28.27	28.06	27.81
Ether extract (EE)	4.91	4.31	4.66
Ash	6.79	6.82	6.40
Crude fiber (CF)	4.27	4.16	4.12
Nitrogen free extract (NFE)	55.76	54.17	57.01
GE **	435	420	435
Protein/energy (P/E) ratio (mg CP/kcal GE)	64.99	66.81	63.93
ME ***	389	375	391

*** Composition of the vitamins and minerals mixture (calculated for each kg of the mixture) in the diet is: Vitamins A, D_3, E, K_3, B_1, B_2, B_6, B_{12}, C, Biotin, Folic acid, and Pantothenic acid, being 5.714.286 IU, 85.714 IU, 7.143 mg, 1.429 mg, 571 mg, 343 mg, 571 mg, 7.143 ug, 857 ug, 2.857 mg, 86 mg, and 1.143 mg, respectively; Minerals: Phosphorus, 28.571 mg; Manganese, 68.571 mg; Zinc, 51.429 mg; Iron, 34.286 mg; Copper, 5.714 mg; Cobalt, 229 mg; Selenium, 286 mg, and Iodine, 114 mg; and Inert essential agent: Starch, 57 g; Natural H, 29 g; and $CaCo_3$ 1000 g.**

**** GE (Gross energy, kcal / 100g DM) = CP x 5.64 + EE x 9.44 + NFE x 4.11 (according to MacDonald *et al.,* 1973).**

***** ME (Metabolizable energy, kcal / 100g DM) was calculated by using factors 3.49, 8.1 and 4.5 kcal/g for carbohydrates, fat and protein, respectively (according to Pantha , 1982).**

Experimental procedure:

The experiment continued for 15 weeks. During the experimental period the fish were fed the experimental diets at a rate of 3% of the live body weight daily. The diet was introduced twice daily, at 8 a.m. and 2 p.m. The amount of feed was adjusted weekly based on the actual body weight changes. Samples of water were taken daily before changes the water and after adding the diets weekly from each aquarium to determine water quality parameters. Light was controlled by a timer to provide a 14h light: 10h dark as a daily photoperiod.

Analytical methods:

Samples of water from each aquarium were taken to determine the water temperature, pH value, dissolved oxygen, alkalinity, hardness, NO_2 and NH_3 concentrations (according to Abdelhamid, 1996). Water temperature as degree centigrade was recorded every day by using a thermometer. The pH value of water was measured daily using an electric digital pH meter (Jenway Ltd, model 350-pH meter). Dissolved oxygen concentration was determined weekly using an oxygen meter **(**model d-5509**).** The NO_2 and NH_3 concentrations were determined by using the commercial kits supplied by Diamond, Diagnostic, Egypt. Determination of DM, CP, EE, CF and ash in the basal diet and in fish body at the start and at the end of the experiment for different groups were carried out according to the methods of A.O.A.C. (1990). At the end of the experiment, three fish were derived from each group for drying at 60ºC for 48 hours and then milled through electrical mill and kept at 4ºC until analysis.

Growth performance and efficiency of feed and protein utilization:

The growth performance and feed utilization parameters were calculated according to the following equations: Average weight gain (AWG) = average final weight (g) - average initial weight (g), Average daily gain (ADG) = average final weight (g) - average initial weight (g) / Time (days), Survival rate (SR%) = total number of fish at the end of the experiment × 100 / total number of fish at the start of the experiment, Relative growth rate (RGR) = average weight gain (g) / average initial weight (g), and Specific growth rate (SGR, % / day) = 100 [ln wt_1- ln wt_o/T], where ln = Natural log., Wt_o = Initial weight (g), Wt_1 = Final weight (g), and T = time in days. However, Feed conversion ratio (FCR) = total feed consumption (g) / Weight gain (g), Protein efficiency ratio (PER) = body weight gain (g) / protein intake (g), Protein productive value (PPV%) = 100 [retained protein (g) / protein intake], and Energy retention (ER%) = 100 [retained energy (Kcal) / energy intake (Kcal), according to Abdelhamid (2003).

Statistical analysis:

The data collected were statistically analyzed by using general linear models procedure adapted by SAS (1996) for users guide. Means were statistically compared using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Water quality parameters:

The physico-chemical parameters of tap water used in this experiment are shown in Table (2). Data showed that all tested water quality criteria were suitable for rearing Nile tilapia fingerlings as cited by Abd El-Hakim *et al*. (2002) and Abdelhamid (2003). Also, Abdelhamid *et al*. (2002) found that similar values were suitable for rearing Nile tilapia. In the same trend, Abdelhamid *et al*. (2004 b&c) tested water quality criteria and reported similar values which were suitable for rearing Nile tilapia fish. However, the ranges of the tested water criteria were 25.5 – 26.5 º C, 7.2 – 7.9 pH , 4.3 – 6.7 mg / l DO, 0.5 – 0.9 mg / l total ammonia and 0.25 – 0.46 mg / l NO_2. Thus, Abd El-Hakim *et al* . (2002) cited the suitable values of water quality parameters for pisciculture as > 5 mg / l DO, and pH 6.7 – 8.6. Also, Abdelhamid (2003) cited the water quality criteria which are suitable for aquaculture in fresh water as pH 6.5 – 9.0, DO > 5 mg / l and NH_3<0.02 mg/l.

Table (2): Ranges of some important measured physico-chemical parameters of water quality.

Water parameters	Treatments					
	B (%)			SD (g fish / l)		
	0	0.5	1	2	3	4
Temperatue (º C)	25.8-26.4	25.7-26.5	25.5-26.4	25.8-26.4	25.7-26.5	25.5-26.4
The pH value	7.3-7.9	7.2-7.9	7.3-7.9	7.3-7.9	7.2-7.9	7.3-7.9
DO (mg/l)	5.0-5.9	4.3-5.9	4.5-6.7	5.0-5.9	4.3-5.9	4.5-6.7
Total ammonia (mg/l)	0.6-0.9	0.6-0.9	0.5-0.9	0.6-0.9	0.6-0.9	0.5-0.9
NO_2 (mg/l)	0.25-0.46	0.26-0.44	0.29-0.43	0.25-0.46	0.26-0.44	0.29-0.43

B = Betaine **SD =Stocking density.**

Growth performance:

Data of growth performance parameters as affected by level of betaine addition and / or stocking density of Nile tilapia fingerlings are illustrated in Table 3. The analysis of variance cleared that there were no significant ($p \geq 0.05$) differences in the initial weight (IW) of the fish, but there were significant differences in the final weight (FW), weight gain (WG) and average daily gain (ADG) due to betaine levels (B) in the diet, stocking density (SD) of the fish as well as in their interaction (B x SD). Increasing the dietary level of betaine addition led to higher ($P \leq 0.05$) FW, WG and ADG, whereas the opposite was true concerning the stocking density, since increasing SD of the fish caused lower ($P \leq 0.05$) FW , WG and ADG. So , the best performance criteria were reported for the highest betaine level (1%) at the lowest stocking density (2g fish / l) which had FW 54.31 g / fish and gained in weight 34.13 g / fish as well as realized ADG of 0.32 g / fish throughout the whole experimental period of 105 days in glass aquaria under the indoor (wet lab) experimental conditions. Similar positive effect of dietary betaine inclusion on fish performance was reported by Magouz (2002b) using 4 g betaine / kg diet of tilapia in glass aquaria and by Abdelhamid *et al*. (2004a) using 2 kg betaine / ton diet of un-sexed Nile tilapia in earthen ponds, but not by Abdelhamid and Ibrahim (2003) using 2 g betaine / kg diet for mono sex Nile tilapia in earthen ponds. Also, Bakeer and Mostafa (2006) revealed that dietary incorporation of betaine (2Kg/Ton) increased (insignificantly) all growth performance parameters of Nile tilapia in cold season. Yet, similar negative effect of increasing stocking density on fish performance was found by El-Saidy and Gaber (2002b).

Table (3): Effect of different betaine levels and density rates on growth performance parameters of Nile tilapia (means* ± SE).

Treatment		I W, g/fish	FW, g/fish	WG, g/fish	ADG, g/fish
Betaine Level					
0 %		20.06±0.01	40.25±0.82c	20.19±0.87c	0.19±0.00c
0.5 %		20.14±0.02	45.52±0.51b	25.38±0.49b	0.24±0.03b
1 %		20.11±0.02	51.58±0.73a	31.47±0.72a	0.30±0.00a
Stocking Rate					
2 g fish/l		20.17±0.03	48.37±1.60a	28.20±1.58a	0.26±0.41a
3 g fish/l		20.08±0.01	45.32±1.65b	25.24±1.65b	0.24±0.41b
4 g fish/l		20.06±0.01	43.67±1.67c	23.61±1.72c	0.22±0.41c
Interaction					
Betaine	**Stocking**				
0 %	**2 g fish /l**	20.08±0.03	43.35±0.05a	23.27±0.02a	0.22±0.00a
0 %	**3 g fish /l**	20.08±0.01	39.70±0.25b	19.62±0.25b	0.19±0.00b
0 %	**4 g fish /l**	20.03±0.01	37.71±0.05c	17.68±0.37c	0.17±0.00c
0.5 %	**2 g fish /l**	20.24±0.05	47.45±0.34a	27.21±0.01a	0.26±0.00a
0.5 %	**3 g fish /l**	20.11±0.00	45.10±0.01b	24.99±0.00b	0.24±0.00b
0.5 %	**4 g fish /l**	20.08±0.02	44.01±0.13c	23.93±0.11c	0.23±0.00c
1%	**2 g fish /l**	20.19±0.04	54.31±0.09a	34.12±0.12a	0.32±0.00a
1%	**3 g fish /l**	20.07±0.02	51.15±0.25b	31.08±0.25b	0.30±0.00b
1%	**4 g fish /l**	20.07±0.01	49.28±0.06c	29.21±0.05c	0.28±0.00c

***Means (in the same column) superscripted with different letters significantly (P≤0.05) differ.**

Growth rates and feed utilization:

Data of relative growth rate (RGR), specific growth rate (RGR), feed intake, feed conversion ratio (FCR) and protein intake are given in Table 4 as means ± standerdard errors. Both variables studied and their interaction affected significantly (P≤0.05) all these above-mentioned parameters. Since increasing the dietary betaine levels led to significant increases in RGR, SGR and feed and protein intakes but reduced the feed conversion efficiency. The opposite trend was recorded with increasing the stocking density of the fish, where all the tested traits were lower, except FCR was better significantly. The best results were obtained from the treatment group fed the 1% betaine supplemented diet and stocked at 2 g fish / l for RGR , SGR and feed and protein intakes ; but concerning the FCR , the best treatment was that fed the no – betaine supplemented diet and stocked at 4g fish / l .

These results agree with those found by Vieira *et al*. (2001) who reported significant differences for body weight gain and FCR in Nile tilapia fish fed betaine supplemented diets. Since betaine increases feed intake (Kasper *et al*., 2002). Magouz (2002b) gave better (P≤0.05) SGR and FCR by betaine inclusion (2-8 g / kg diet) in Nile tilapia diet (in glass aquaria.)

Abdelhamid *et al*. (2004a) working on Nile tilapia in earthen ponds, reported better weight gain, RGR, SGR, but lower feed conversion by betaine including diets (1-2 kg / ton). Moreover, Bakeer and Mostafa (2006) revealed that betaine dietary inclusion significantly improved FCR. Similar negative effects of increased crowding were reported by El-Saidy and Gaber (2002b) on Nile tilapia feed utilization. Since crowding stress negatively affected the physiological functions of Nile tilapia (Abdel-Tawwab *et al*., 2005).

Table (4): Means* ± SE of growth rates and feed and nutrient utilization of Nile tilapia fed the experimental diets containing different levels of betaine and three stocking rates.

Treatment		RGR	SGR	Feed Intake g/fish	FCR	Protein intake
Betaine Level						
0 %		1.07±0.06c	0.66±0.04c	40.25±0.27c	1.99±0.06c	2.88±0.02c
0.5 %		1.26±0.05b	0.78±0.02b	45.47±0.01b	1.79±0.03b	3.36±0.02b
1 %		1.58±0.03a	0.90±0.03a	1.58±0.24a	1.63±0.04a	3.37±0.01a
Stocking Rate						
2 g fish/l		1.39±0.13a	0.83±0.07a	48.37±0.53a	1.71±0.05a	3.38±0.11a
3 g fish/l		1.25±0.13b	0.77±0,08b	45.32±0.55b	1.79±0.06b	3.31±0.12b
4 g fish/l		1.19±0.15c	0.74±0.09c	3.62±0.55c	1.87±0.06c	3.23±0.12c
Interaction						
Betaine	**Stocking**					
0 %	**2 g fish /l**	1.16±0.00a	0.73±0.00a	43.35±0.03a	1.86±0.00a	2.98±0.00a
0 %	**3 g fish /l**	0.98±0.01b	0.65±0.01b	39.70±0.14b	2.02±0.01b	2.87±0.01b
0 %	**4 g fish /l**	0.88±0.00c	0.60±0.01c	37.71±0.03c	2.13±0.00c	2.80±0.00c
0.5 %	**2 g fish /l**	1.34±0.00a	0.81±0.01a	47.45±0.02a	1.74±0.01a	3.41±0.01a
0.5 %	**3 g fish /l**	1.24±0.01b	0.77±0.00b	45.10±0.00b	1.80±0.02b	3.41±0.04a
0.5 %	**4 g fish /l**	1.19±0.05c	0.75±0.00c	43.86±0.13c	1.83±0.01b	3.27±0.01b
1%	**2 g fish /l**	1.69±0.01a	0.94±0.01a	54.31±0.05a	1.05±0.00a	3.74±0.00a
1%	**3 g fish /l**	1.55±0.00b	0.89±0.01b	51.15±0.14b	1.64±0.00b	3.65±0.02b
1%	**4 g fish /l**	1.46±0.00b	0.86±0.00b	49.28±0.03c	1.68±0.00c	3.63±0.00b

***Means (in the same column) superscripted with different letters significantly ($P\leq0.05$) differ.**

Data of protein utilization in terms of protein productive value (PPV) and protein efficiency ratio (PER) as well as survival rate (SR %) are presented as means ± standard errors in Table (5). There were no significant differences among treatments in SR. Also, there was no clear trend for the effect of betaine inclusion in Nile tilapia diet on their PPV; whereas PER significantly ($P\leq0.05$) increased by elevating dietary betaine levels . However, increasing the stocking density of the experimented fish reduced significantly ($P\leq0.05$) either traits (PPV % and PER). Therefore, the best PPV % was realized in the fish group received the free-betaine diet and stocked at 2 g fish / l. Yet, the best PER was reflected by the fish group received 1 % betaine supplemented diet and stocked at 2 g fish / l .

Table (5): Means* ± standard errors of protein productive value (PPV), protein efficiency ratio (PER) and survival rate (SR %) of the tested Nile tilapia fingerlings as affected by dietary inclusion of betaine at different stocking rates

Treatment		PPV	PER	SR
Betaine Level				
0 %		13.56±0.16a	7.01±0.08c	100±0.00
0.5 %		13.12±0.11b	7.48±0.07b	100±0.00
1 %		13.52±0.13a	8.43±0.09a	100±0.00
Stocking Rate				
2 g fish/l		13.89±0.09a	8.29±0.02a	100±0.00
3 g fish/l		13.25±0.11b	7.57±0.01b	100±0.00
4 g fish/l		13.05 ±0.02c	7.26±0.61c	100±0.00
Interaction				
Betaine	**Stocking**			
0 %	**2 g fish /l**	14.17±0.01a	7.80±0.00a	100±0.00
0 %	**3 g fish /l**	13.44±0.02b	6.83±0.00b	100±0.00
0 %	**4 g fish /l**	13.08±0.02c	6.31±0.00c	100±0.00
0.5 %	**2 g fish /l**	13.51±0.03a	7.90±0.00a	100±0.00
0.5 %	**3 g fish /l**	12.83±0.15b	7.26±0.00b	100±0.00
0.5 %	**4 g fish /l**	12.02±0.06b	7.25±0.00c	100±0.00
1%	**2 g fish /l**	13.99±0.04a	9.02±0.00a	100±0.00
1%	**3 g fish /l**	13.50±0.01b	8.44±0.00b	100±0.00
1%	**4 g fish /l**	13.07±0.00c	7.98±0.00c	100±0.00

***Means (in the same column) superscripted with different letters significantly (P≤0.05) differ.**

In this respect, Magouz (2002b) mentioned that betaine (2-8 g / kg diet) significantly improved PER and PPV as compared with the controal (betaine free) tilapia reared in glass aquaria. Yet, Abdelhamid and Ibrahim (2003) reported lower PER and SR at 3 kg Betafin® (betaine) per ton diet for earthen ponds reared mono-sex Nile tilapia compared with the unsupplemented (control). However, Abdelhamid *et al*. (2004a), working on not-sexed Nile tilapia in earthen ponds also, found that 1 and 2 kg betaine / ton diet not significantly improved PER , but significantly improved PPV %. Concerning the negative effect of increasing stocking rate on PPV % and PER, Omar *et al.* (1997) came to similar results. They added that elevated stocking rate reduced also SR of tilapia fish. El-Saidy and Gaber (2002b) found that stocking rate did not affect SR of Nile tilapia.

Body composition:

From Table 6, it is clear that increasing dietary betaine supplementation caused increases in dry matter (DM), crude protein (CP) and to some extent also in ash contents of the tested fish. Yet, the ether extract (EE) percentage decreased by elevating the betaine level. Also, elevating stocking rate of fish positively affected their body composition concerning DM mainly and CP as well as ash, but decreased EE%. Betaine also improved fat distribution in fish fillet (Finnfeeds, 1999). In this respect, Magouz (2002b) mentioned that tilapia fish (initial weight 22g / fish) body composition was not affected by the supplementation of betaine in the diet (2-8 g/ kg) containing 29 % CP for 56 days. Yet, Abdelhamid *et al*. (2004a) found that 2 kg betaine / ton feed of Nile tilapia (initial weight 22g / fish) reared in earthen ponds (at stocking rate of 50 thousand / faddan) led to significant (P≤0.05) increased in DM and EE and significant (P≤0.05) decreased in CP and ash percentages of the dorsal muscles. Omar *et al*. (1997) reported that increasing stocking density significant (P≤0.05) lowered DM and CP contents of *O. nilaticus* but not affected EE and ash contents of the fish. Moreover, El-Saidy and Gaber (2002a) registered significant (P≤0.05) influences of stocking density of whole fish body composition as % of DM , CP , EE and ash , since DM , EE and ash contents decreased whereas CP% increased by the increase in stocking rate . A negative relationship was noticed between CP and EE contents of fish body but a position relationship between CP and ash contents was recorded too (Abdelhamid *et al* ., 1999 & 2000 and El-Saidy and Gaber , 2002b).

Table (6): Means* of carcass chemical composition (%dry matter bases) of Nile tilapia fed on the experimental diets containing different level of betaine.

Treatment		DM	CP	EE	Ash
Betaine Level					
0 %		27.24±1.65b	52.47±0.04c	32.04±0.34a	15.48±0.31b
0.5 %		28.66±2.17a	54.99±0.22b	28.22±0.32b	16.78±0.10a
1 %		28.74±0.90a	56.42±0.01a	27.30±0.20c	16.61±0.20a
Stocking Rate					
2 g fish/l		25.94±1.01c	54.09±0.99c	29.73±1.47a	16.16±0.49b
3 g fish/l		28.30±2.01b	54.66±1.00b	29.14±1.32a	16.19±0.42b
4 g fish/l		30.40±0.13a	54.79±1.00a	28.68±1.20b	16.52±0.24a
Interaction					
Betaine	**Stocking**				
0 %	**2 g fish /l**	27.43±0.00b	52.40±0.03b	32.54±0.00a	15.02±0.03b
0 %	**3 g fish /l**	23.84±0.02c	52.45±0.00b	32.15±0.39a	15.39±0.39a
0 %	**4 g fish /l**	30.46±0.00a	52.55±0.00a	31.42±0.00b	16.02±0.00a
0.5 %	**2 g fish /l**	23.68±0.00c	54.48±0.00c	28.98±0.00a	16.53±0.00c
0.5 %	**3 g fish /l**	31.65±0.00a	55.12±0.00b	27.94±0.00b	16.93±0.00a
0.5 %	**4 g fish /l**	30.65±0.00b	55.37±0.00a	27.74±0.00c	16.88±0.00b
1%	**2 g fish /l**	26.72±0.32c	55.39±0.00c	27.68±0.00a	16.93±0.00a
1%	**3 g fish /l**	29.40±0.03b	56.41±0.00b	27.34±0.00a	16.24±0.00b
1%	**4 g fish /l**	30.10±0.00a	56.46±0.00a	26.88±0.23b	16.65±0.23a

***Means (in the same column) superscripted with different letters significantly (P≤0.05) differ.**

Economic efficiency:

The increase in feed intake by elevating betaine levels in the fish diet led to increased feed costs , but was accompanied with higher fish weight gain; so, led to lower feed costs /kg fish weight gain ,i.e. caused economical feeding and production (Table 7). This result disagreed with the findings of Abdelhamid and Ibrahim (2003) who found that adding 3kg betaine / ton of mono-sex Nile tilapia diet led to lower fish productively, higher feed costs /kg weight gain, lower feed efficiency and hence lower economic efficiency than the un-supplemented (control) earthen ponds. Yet, in another study (Abdelhamid *et al*., 2004b), the net return from earthen ponds stocked with un-sexed Nile tilapia and fed a diet containing 2kg betaine /ton diet was higher than the unsupplemented ponds, this was due to the higher final biomass and % tilapia of class No.1 as well as higher dressing % and boneless meat % for betaine usage. However, betaine significantly improved the growth of fish, so led to markedly better production economy. Recently, Bakeer *and* Mostafa (2006) mentioned that dietary inclusion of betaine improved the economic efficiency of tilapia production.

Generally, there is a negative relationship between stocking density and fish production (g/fish) with r^2 = 0.996 as calculated by Huang and Chiu (1997) for tilapia fry. Also, El-Saidy and Gaber (2002b) found that 75 fish/m^3 as stocking density was lower in net profile than 25 or 50 fish/m^3, since high rearing density causes deleterious effect in fish farm (Abdel-Tawwab *et al*., 2005).

Table (7): Effect of different betaine levels and density rates on economic efficiency of Nile tilapia (means* ± SE).

Treatment		Feed intake (g)	Cost(LE of one ton diet)	Total gain(g)	Feed cost/kg gain(LE)
Betaine Level					
0 %		40.25±0.27c	1758.64±0.17c	20.19±0.27c	0.17±0.00b
0.5 %		45.47±0.01b	1872.24±0.79b	25.38±0.16b	0.17±0.03b
1 %		51.58±0.24a	1987.84±1.07a	31.47±0.24a	1.16±0.00a
Stocking Rate					
2 g fish/l		48.37±0.53a	1872.24±11.02a	28.20±0.25c	0.15±0.00c
3 g fish/l		45.32±0.55b	1872.24±11.24a	25.24±0.55b	0.17±0.00b
4 g fish/l		43.62±0.55c	1872.24±11.24a	23.61±0.54a	0.18±0.00a
Interaction					
Betaine	**Stocking**				
0 %	**2 g fish /l**	43.35±0.03a	1757.64±2.18a	23.27±0.01a	0.15±0.00c
0 %	**3 g fish /l**	39.70±0.14b	1757.64±2.18a	19.62±0.15b	0.17±0.00b
0 %	**4 g fish /l**	37.71±0.03c	1757.64±2.18a	17.68±0.53c	0.19±0.00a
0.5 %	**2 g fish /l**	47.45±0.02a	1872.24±2.18a	27.21±0.17a	0.16±0.00b
0.5 %	**3 g fish /l**	45.10±0.00b	1872.24±2.18a	24.99±0.00b	0.18±0.00a
0.5 %	**4 g fish /l**	43.86±0.13c	1872.24±2.18a	23.93±0.06c	0.18±0.00a
1%	**2 g fish /l**	54.31±0.05a	1986.84±2.18a	34.12±0.07a	0.15±0.00c
1%	**3 g fish /l**	51.15±0.14b	1986.84±2.18a	31.08±0.19b	0.16±0.00b
1%	**4 g fish /l**	49.28±0.03c	1986.84±2.18ca	29.21±0.03c	0.17±0.00a

***Means (in the same column) superscripted with different letters significantly (P≤0.05) differ.**

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تأثير إضافة البيتائين في العليقة و/أو كثافة التخزين على أداء البلطي النيلى

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أقسام الإنتاج الحيواني بكليات الزراعة جامعة المنصورة* ، وجامعة كفر الشيخ ، والمركز القومي للبحوث بالقاهرة*****

تمت هذه الدراسة لتقييم مدى فائدة الإضافات الغذائية من أحد المستحضرات الطبية (بيتافين /أي بيتائين) لتقليل الإجهاد على السمك من جراء زيادة معدل تخزين اصبعيات بلطي نيلى, وعليه تم تقييم تأثير إضافة البيتائين إلى العليقة (صفر، ٠,٥ ، ١%) على أداء النمو والحياتية، ومكونات الجسم، وكفاءة استخدام الغذاء، والكفاءة الاقتصادية، لقياس مدى تحملها للعوامل الضاغطة تحت الكثافات المختلفة لمدة ١٥ أسبوعا، فاستخدمت اصبعيات بلطي نيلى غير مجنس بوزن ابتدائي حوالي ٢٠ جم في ثلاثة كثافات مختلفة (٢ ، ٣ ، ٤ جم سمك/لتر). وتم تغذية الأسماك في فترة التجربة على الغذاء الصناعي (٢٨% بروتين) بمعدل ٣% من وزن الجسم يوميا, على مرتين. فكانت التجربة عاملية لدراسة ٣ تركيزات بيتائين في العليقة على ٣ كثافات تخزين للسمك , بمعدل ٣ مكررات (أحواض) لكل معاملة .

أدت هذه الدراسة إلى بعض النتائج التي يمكن أن تلخص في أن العلائق المحتوية على نسب ١ ، ٠,٥ % بيتائين كانت أفضل في كل الاختبارات المقاسة بالمقارنة بالكنترول (الخالية من البيتائين) , ومن ناحية أخرى تبين النتائج أن الكثافة التخزينية (٢ ، ٣) جم سمك / لتر كان معدلها أفضل في زيادة الوزن ومعدل الوزن اليومي للجسم ومعدل النمو النسبي والنوعي أكثر من الكثافة ٤ جم سمكة / لتر. بزيادة بيتائين العلف زادت معدلات النمو واستهلاك العلف والبروتين معنويا، وانخفضت كفاءة التحويل الغذائي معنويا كذلك، وبزيادة كثافة تخزين السمك تنخفض معدلات النمو واستهلاك العلف والبروتين معنويا وتتحسن كفاءة التحويل الغذائي معنويا. بزيادة نسبه بيتائين العلائق زادت الاستفادة من البروتين معنويا، ولم تتأثر نسبة الحياتية، بينما بزيادة كثافة تخزين السمك انخفضت الاستفادة من بروتين العليقة معنويا، وإن لم تتأثر نسبة الحياتية. بزيادة نسبه بيتائين العلائق زادت النسبة المئوية لكل من المادة الجافة والبروتين (ولحد ما الرماد)، وقلت نسبة المستخلص الإثيرى في جسم الأسماك، وبزيادة معدل تسكين السمك زادت كذلك النسبة المئوية للمادة الجافة (ولحد ما البروتين والرماد)، وقلت نسبة المستخلص الإثيرى في جسم الأسماك. أدت زيادة نسبة بيتائين العلائق إلى زيادة استهلاك العلف وزيادة سعر العلف ، لكن زيادة الوزن في الأسماك عوضت ذلك مما أدى إلى انخفاض تكاليف التغذية اللازمة لإنتاج كيلو زيادة في وزن الأسماك، أي أن احتواء علائق الأسماك على البيتائين تحسن من اقتصاديات استزراع الأسماك، وعلى ذلك أثبتت النتائج أن إضافة ١,٠ % بيتائين في الغذاء هو الأفضل لسمكة البلطي المخزنة بكثافة ٢ جم سمك/لتر لزيادة نمو واقتصاديات إنتاج الأسماك.