4. RESULTS AND DISCUSSION

4.1. First Experiment:

4.1.1. Effect of dietary L-carnitine on grow th performance of Nile tilapia:

4.1.1.1. Body weight (BW):

Average initial body weight (BW) of Tilapia fish *Oreochroznis niloticus* ranged from 1.60 to 1.66 g with non significant differences between groups (Tables 2 and 3) indicating the random distribution of the experimental fish. After 90 days of the experimental start (end of the experimental), final body weight (BW) ranged between 19.28 ± 0.94 and 27.94 t 0.94 and the differences in body weight (BW) among the different treatments were significant ($P < 0.001$).

Results of Table (2) indicated that the dose 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet (group 6) resulted in highest body weight (BW) (27.94 g) compared to the control group (0 L-carnitine) and the difference was significant ($P < 0.001$) and the other doses caused also significant increase in body weight compared to the control group.

The present results are in accordance with the finding of **Soltan** *et aL* **(2004)** who reported that all L-carnitine levels (300 to 1500 mg/kg diet at each of two lipid levels (5 and 10%) significantly ($P < 0.001$) increased the final body weight of Nile tilapia.

Table (2): Least squares means and standard errors for the effect of dietary L- carnitine levels on body weight (BW) (g) and body length (BL) (cm) of Nile Tilapia fish.

Treatment	No.*	Body weight (g) (BW)		Body length (cm) (BL)	
		Initial	Final	initial	Final
Group 1	50	1.63 ±0.07	19.28 ±0.94c	4.41 ±0.07	10.24 ±0.16 c
Group 2	50	1.62 ± 0.07	22.92 ±0.94 b	4.49 ±0.07	10.64 ±0.16 be
Croup 3	50	1. 60 10.07	22.14 -10.94 l'	4.40 10.07	10.57 -1 0.16 bc
Group 4	50	1.61 ± 0.07	24.41 ±0.94b	4.49 ±0.07	11.30 ± 0.161'
Group 5	50	1. 64 ± 0.07	24.40 ±0.94 b	4.41 ±0.07	11.04 ±0.16 b
Group 6	50	1.66 ± 0.07	27.94 ±0.94 a	4.47 ±0.07	11.54 ± 0.16 a

Mparie witl, 4•1-..r. same 1.....____ • c co umn are not significantly different.

* Average of 2 replicates for each treatment.

Superscript letters are seted based on the actual means.

Group 1 = Control (0 L-carnitine).

Group 2 = 300 mg L-carnitine / kg basal diet

Group 3 = 10 g Lysine + 15 g methionine / kg basal diet.

Group 4 = 15 g lysine + 7 g methionine / kg basal diet.

Group 5 = 10 g lysine + 15 g methionine + 300 mg L-carnitine / kg basal diet.

Group 6 = 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet.

Table (3): F-ratios of least square analysis for the effect of dietary L-carnitine levels on body weight (BW) g and body length (BL) cm of Nile Tilapiafish.

SOV	dF	F-ratio			
		Body weight (g) (BW)		Body length (cm) (BL)	
		Initial	Final	Initial	Final
Treatment	5	0.11	9.43***	0.38	7.74***
Replicates	1	0.01	0.10	0.07	0.88
Error df	293				
Error MS		0.215	43.893	0.249	1.325

*** = P <0.001

In this respect, results of other authors showed that dietary L-carnitine seemed to increase the final body weight of Nile Tilapia fish **(Kumar and Jayaprakas, 1996; Jayaprakas** *et aL,* **1996; Becker** *et aL,* **1999; Azab** *et al.,* **2002 and Dikes** *et al.,* **2003),** Carp **(Focken** *et aL,* **1997 and Zhang** *et aL,* **2002),** trout **(Rodahuscord, 1995),** juvenile hybrid striped bass **(Twibell and Brown, 2000),** red seas bream **(Chatzifotis** *et aL,* **1995 and 1996),** European sea bass **(Santulli and D'Amelio, 1986)** and African catfish **(Torreele** *et aL,* **1993 and Twibell and Brown, 2000).**

Furthermore **Abdel-Ilakim** *et al.* **(2006)** repored that supplementing growing Nile tilapia diets with both methionin and lysine to reach 30% over the recommended levels improved significantly inal weights, weight gains protein productive value and energy utilization. However, it has insignificant effects on feed conversion ratio and specific growth rate.

On the other hand, **Chatzifotis** *et aL* (1996) found that carnitine supplementation at a level of 2 g/kg^{-1} diet increased red sea brean growth fed 14 g lysine / kg' diet but did not cause any effect on growth in fish fed the diet containing 10 g lysine / diet.

4.1.1.2. Body lenu,th (BL):

Average initial body length (BL) of Nile tilapia fish *Oreochromis niloticus* ranged from 4.40 to 4.49 cm with no significant differences between groups (Tables 2 and 3) at the start of the experiment. At the end of experiment (after 3 months) the *final* body length (BL) had ranged from 10.24 and 11.54 cm and the differences among the different treatments were significant (P <

0.001). Results in Table (2) indicated that the dose (15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet) increased body length (BL) (11.54 cm) compared to the control group (0 L-carnitine) and the difference was significant also the other tested doses caused significant increase in body length compared to the control group. Similar results were obtained by **Soltan *et at* (2004)** who found that, all dietary L-carnitine levels studied (300 to 1500 mg / kg diet) significantly ($P < 0.001$) increased body length for tish fed the two fat levels 5 and 10%.

These results are in agreement with those reported by **Litz (1993)** who attributed the increased growth performance, (body weight and body length) of the carnitine supplemented fish groups was attributed to the increased feed intake in the trout fish.

4.1.1.3. Weight (WG);

The weight gain (WG) values had ranged from 18.05 g to 26.28 g and the differences between weight gain (WG) values were significant ($P < 0.01$) as shown in Tables (4 and 5). The highest weight gain (WG) value (26.28 g) was obtained with fish fed the diet contained 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet and the lowest weight gain (WG) value (18.05 g) was obtained with fish fed the control diet whereas the other doses released higher weight gain compared with control diet. Similar results were also obtained by **Azab *et al.* (2002)** who found that weight gain of Nile tilapia, *0. niloticus* was significantly increased in fish groups fed diets contained L-carnitine at levels of 300, 600 or 900 mg / kg compared to the control. Also, **Soltan *et al.* (2004)** found that, all dietary L-carnitine levels studied (300 to 1500 mg/kg

Table (4): Least squares means and standard errors for the effect of dietary L- carnitine levels on weight gain (WG) (g) and specific growth rate (SGR) of Nile Tilapia fish.

Doses	No.*	Weight gain (g) (WG)	Specific growth rate (SGR)
Group 1	2	18.05 ± 1.17^{e}	2.76 ± 0.04^{e}
Group 2	2	21.30 ± 1.17^{bc}	2.93 ± 0.04^{b}
Group 3	2	20.54 ± 1.17^{bc}	2.91 ± 0.04^{b}
Group 4	2	22.81 ± 1.17^{ab}	3.02 ± 0.04^{ab}
Group 5	2	22.75 ± 1.17^{ab}	2.99 ± 0.04^{ab}
Group 6	2	26.28 ± 1.17^{a}	3.12 ± 0.04^{a}

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

* Average of 2 replicates for each treatment.

Superscript letters are scted based on the actual means.

Group 1 = Control (0 L-carnitine).

Group 2 = 300 mg L-carnitine / kg basal diet

Group 3 = 10 g Lysine + 15 g methionine / kg basal diet.

Group 4 = 15 g lysine + 7 g methionine / kg basal diet.

Group 5 = 10 g lysine + 15 g methionine + 300 mg L-carnitine / kg basal diet.

Group 6 = 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet.

Table (5): F-ratios of least squares analysis for the effect of dietary L-carnitine levels on weight gain (WG) and specsfic growth rate ،SGR) of Nile Tilapia fish.

SON'	(I F	F-ratio	
		Weight gain (g) (WG)	Specific growth rate (SGR)
Treatment	5	5.48**	**8.04****
Error df			
Error MS		2.75	**0.003**

** = P < 0.01

diet) significantly ($P < 0.001$) increased weight gain of Nile tilapia whereas the diet contained 900 mg/kg L-carnitine released the higher weight gain. These results are in agreement with the finding of **Twibell and Brown (2000)** who found that feed intake and weight gain were significantly increased when hybrid striped bass fish fed on diets containing 369.7 mg L-carnitine / kg diet, compared to fish fed the basal diet containing 2.1 mg carnitine / kg diet.

On the other hand, **Rodahutscord (1995)** found that dietary treatment of L-carnitine had no significant effect on weight gain. In this respect, **Hamackova *et al.* (1998)** reported that the use of L-carnitine 250 mg/kg for feeding carp, did not have a significant influence on growth parameters although total and daily relative weight gains rates were rates were better in comparison with the control group by 21.4 and 21.5%, respectively.

On contrast, dietary L-carnitine did not affect WG of channel catfish **(Burtle and Liu 1994),** rainbow trout **(Rodahutscord, 1995)** or Atlantic salmon **(Ji *et al.*, 1996).** This variation in the effect of L-carnitine in different species of fish as recorded by several authors do not attributed to the concentration in L-carnitine in the diet, because low carnitine concentration (150 mg/kg diet) caused an increase in WG of tilapia **(Jayaprakas *et al.*, 1996),** while high concentration of 3700, 1000 and 230 mg/kg diet had no significant effect on growth rates of Atlantic salamon **(Ji *et al.*, 1996),** channel catfish **(Burtle and Liu, 1994)** or rainbow trout **(Rodahutscord, 1995).**

4.1.1.4. Specific growth rate (SGR):

The specific growth rate (SGR) values hadranged from 2.76 to 3.12 and the differences between specific growth rate (SGR) values were significant ($P < 0.01$) as shown in Tables (4 and 5). The highest specific growth rate (SGR) value (3.12) was obtained with fish fed the diet contained (15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet) and the lowest specific growth rate (SGR) value (2.76) was obtained with fish fed the control diet. Also the other doses (group 2, 3, 4 and 5) caused a significant increase in SGR compared with control group (group 1). These results confirmed the findings of **Soltan *et al.* (2004)** who stated that, all L-carnitine levels studied (300-1500 mg/kg diet) caused significant ($P<0.001$) improvement in specific growth rate (SGR) of Nile tilapia fish. Also with **Azab *et al* (2002)** found that, L-carnitine caused a significant increase in specific growth rate (SGR) of Nile tilapia fed diets contained L-carnitine levels of 300, 600 or 900 mg/kg diet. It was found also by **Dikel *et al* (2003)** that, addition of L-carnitine at a level of 500 mg/kg diet significantly increased growth rate of Nile tilapia fingerlings by 7.9% compared to the control.

Similar finding was obtained by **Becker and Focken (1995)** who showed better specific growth rate for carp fish fed the diet containing L-carnitine at 400 and 600 mg / kg levels, respectively, and by **Jayaprakas *et al.* (1996)** who reported that, increasing dietary L-carnitine in male of *O. mossambicus* diets significantly enhanced growth performance.

In this respect, **Schuhmacher and Gropp (1998)** found that incorporation of L-carnitine 450 mg / kg diet with lysine 5.3 g and

methionine 1.5 g, caused significant improvement in specific growth rate in rainbow trout fingerlings.

On the other hand, **Hamackova *et aL* (1998)** found that feeding common carp on diets containing L-carnitine 250 mg/kg did not have a significant influence on growth parameters although total and daily relative weight gains and specific growth rates were better in comparison with the control group by 21.4, 21.5 and 12.5% respectively.

4.1.2. Feed utilization:

With regard to the effect of L-carnitine levels on feed intake (FI), feed conversion ratio (FCR) and protein efficiency ratio (PER) of Nile tilapia, results of Tables (6 and 7) indicated that, compared to the control, all L-carnitine levels significantly ($P < 0.001$) increased feed intake (FI) and improved ($P < 0.001$) feed conversion ratio (FCR) but had no significant effect on protein efficiency ratio (PER). As described in Table (6) the higher feed intake value (51.50 g / fish) was obtained with fish fed the diet contained (15 g lysine +7 g methionine + 300 mg L-carnitine / kg basal diet) compared with the control group and the best values (1.21), (1.75) of feed conversion ratio and protein efficiency ratio were recorded also by fish fed diet on the same diet (15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet).

These results are in agreement with the finding of **Soltan *et* (2004)** who found that, all L-carnitine levels (300 to 1500 mg/kg diet) increased FI and improved (FCR) but had no significant effect on (PER).

Table (6): Least square means and standard errors for the effect of dietary L- carnitine levels on feed utilization of Nile la ia fish.

Doses	No.*	Feed intake (g) / fish (FI)	Feed conversion ratio (FCR)	Protein efficiency ratio (PER)
Group 1	2	47.15 ± 0.06 f	1.73 ± 0.04a	1.67 ± 0.02
Group 2	2	48.66 ± 0.06 e	1.54 ± 0.04b	1.70 ± 0.02
Group 3	2	49.95 ± 0.06 C	1.62 ± 0.04b	1.71 ± 0.02
Groups	2	49.15 ± 0.06 d	1.47 ± 0.04c	1.74 ± 0.02
Group 5	2	51.15 ± 0.06 b	1.33 ± 0.04F	1.73 ± 0.02
Group 6	2	51.50 ± 0.06 a	1.21 ± 0.04b	1.75 ± 0.02

Means with the same letters in each column are not sign"ican ydifferent.
* Average of 2 replicates for each treatment.
Superscript letters are seted based on the actual means.
Group 1 = Control (0 L-carnitine).
Group 2 = 300 mg L-carnitine / kg basal diet
Group 3 = 10 g Lysine + 15 g methionine / kg basal diet.
Group 4 = 15 g lysine + 7 g methionine / kg basal diet.
Group 5 = 10 g lysine + 15 g methionine + 300 mg L-carnitine / kg basal diet.
Group 6 = 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet.

Table (7): **F-ratios of least squares analysis for the effect of dietary L-carnitine levels on feed utilization of**

SOV	dF	F-ratio		
		Feed intake (g) / fish (FI)	Feed conversion ratio (FCR)	Protein efficiency ratio (PER)
Treatment	**5**	7047.78***	35.22***	0.115
Error df	**6**			
Error MS		0.007	0.004	0.001

*** = P < 0.001

Also, Becker ***et at*** (1999) found that, the Tilapia fish feed on the diets contained 150 and 300 mg L-carnitine / kg diet carnitine showed increased growth, feed conversion and protein efficiency ratio and did not alter whole body composition.

Similarly, several researchers have speculated that increasing growth rates of fish fed supplemental carnitine may due to its role in improving FCR via increasing fatty acid oxidation and increasing utilization of dietary energy as observed by **Jayaprakas *et aL* (1996), Kumar and Jayaprakas (1996), Becker *et aL* (1999), Azab *et aL* (2002) and Soltan *et aL* (2004)** in tilapia, **Becker and Focken (1995) and Hamackova *et aL* (1998)** in carp, **Torreele *et aL* (1993) and Ozorio *et al.* (2001)** in catfish, **Litz (!993) and Schuhmacher and Gropp (1998)** in trout and finally **Chatzifotis *et al.* (1995)** in red sea bream.

The results of the present study showed that the important role of L-carnitine on metabolic rate is derived both from endogenous synthesis and diet as carnitine is synthesized from lysine and methionine **(Bremer, 1961 and Tanphaichitr *et aL*, 1971).** In this respect, **Ozorio *et aL* (2002)** with African catfish suggest that dietary L-carnitine supplementation may increase fatty acid oxidation and possibly decrease amino acid consumption for energy.

4.1.3. Proximate analysis of whole fish of Nile tilapia.

Results of proximate analysis of whole tilapia fish at the end of the experiment are illustrated in Tables (8 and 9). As described in these Tables, it was found that dietary L-carnitine significantly increased protein ($P<0.001$) and ash content ($P < 0.01$) of boies

Table (8): **Least square means and standard errors for the effect of dietary L- carnitine levels on chemical** com osition of whole Nile **ia fish body.**

Doses	No.*	Dry matter %	Protein %	Fat %	Ash %
Group 1	6	32.07 10.33^{6}	56.04 ±0.63^{bc}	30.6210.57^{a}	10.7210.77`
Group 2	6	32.4010.33^{b}	55.41±0.63`	30.04±0.57^{a}	10.78±0.77^{b}
Group 3	6	32.78±0.33^{ab}	55.84±0.63^{bc}	30.1810.57^{a}	11.06±0.77^{ab}
Group 4	6	31.88±0.33^{ab}	55.96±0.63^{be}	29.6510.57^{6}	11.28±0.77^{a}
Group 5	6	31.6610.33th	57.7910.63^{6}	29.2010.57^{6}	**11.8610.77^{6}**
Group 6	6	31.31±0.33^{b}	59.34±0.63^{a}	28.12±0.57^{b}	11.93±0.77^{h}

Means with the same letters in each column are not sign' ican
* Average of 2 replicates for each treatment.
Superscript letters are seted based on the actual means.
Group 1 = Control (0 L-carnitine).
Group 2 = 300 mg L-carnitine / kg basal diet
Group 3 = 10 g Lysine + 15 g methionine / kg basal diet.
Group 4 = 15 g lysine + 7 g methionine / kg basal diet.
Group 5 = 10 g lysine + 15 g methionine + 300 mg L-carnitine / kg basal diet.
Group 6 = 15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet.

Table (9): F-ratios of least squares analysis for the effect of dietary L-carnitine levels on body weight (BW) g and body length (BL) c **m of NieTila ia fish.**

SOV	dF	F-ratio			
		Dry matter %	Protein %	Fat %	Ash %
Treatment	5	1.68	5.81***	3.94**	3.36**
Replicates	1	0.29	0.10	2.19	1.42
Error df	29				
Error MS		0.637	2.383	1.916	3.562

**=P<0.01.
***=P <0.001.

flesh. While fat content was decreased ($P < 0.01$) but there was no significant effect on the percentage of dry matter. As shown in Table (8) the higher protein content (59.34%) and the lowest fat content (28.12%) were obtained with fish fed the diet contained (15 g lysine + 7 g methionine + 300 mg L-carnitine / kg basal diet) and diet contained (10 g lysine + 15 g methionine + 300 mg L-camitine / kg basal diet), respectively compared with control group.

Sollan et al. **(2004)** came to the same results with tilapia fish. They found that L-camitine in tilapia diets significantly increased protein and ash contents of fish flesh and decreased fat content of fish flesh while moisture content showed no clear trend.

In this connection **Zhang *et al.*** **(2002)** reported that averages muscle protein contents of common carp increased by 3.13% and fat contents decreased by 11.45% compared to the control group when fed on diets containing L-carnitine at 15 mg/kg level supplemented in diets contained 28, 32 or 36% protein in levels.

Azab *et aL* **(2002)** found no significant effect of dietary L-camitine on tissue composition at low fat level (10%), while in high level of dietary fat (15%), L-carnitine caused a significant increase in tissue protein. In the same respect, dietary L-carnitine reduced lipid content of rohu **(Keshavanath and Renuka, 1998),** tilapia **(Jayaprakas *et al.,*** **1996),** channel catfish **(Burtle and Liu, 1994)** and Atlantic salmon **(Ji *et aL,*** **1996).** In contrast, several authors found that, dietary carnitine did not alter tissue composition of hybrid striped bass **(Twibell and Brown, 2000),** rainbow trout **(Rodahutscord, 1995)** or hybrid tilapia **(Becker *et al.,*** **1999).**

4.2. Second Experiment:

4.2.1. Effect of flumetluine on growth performance of Nile Tilapia *Oreochormis niloticus :*

4.2.1.1. Body weight (BW):

Average initial body weight (BW) of Tilapia fish, *0. niloticus* had ranged from 13.65 to 13.88 g with in significant differences between groups (Tables 10 and **11)** indicating the random distribution of the fish among the six treatments. After 90 days of the experimental start average body weight (BW) had ranged between 31.73 and 37.57 g and the difference in body weight among the different treatments were significant ($P<0.01$).

Results in Table (10) indicated that the dose 10mg/kg of body weight/day (group 4) results in the highest body weight compared to the control group (0-flumequine) and the differences were significant ($P > 0.01$). also the other doses in final weight caused increase in body weight but no difference compared with control group were insignificant. The present results are in accordance with the finding of Azab ***et al*** **(2003)** who found that flumequine in dose 10mg/kg of body weight/ day caused significant increase in body weight of Nile Tilapia ***0.*** *niloticus* at the experimental periods, 3, 6 and 9 weeks from experimental start. Also, **Fath El-Bab (2006)** reported that body weight of Tilapia fish fed the diet contained 10 mg Flu/kg of body weight / day were significantly ($P < 0.05$) higher than that fed the other treatments at the experimental periods 2, 15, 30, 45, 60 and 75 days after hatching.

Table (10): Least square means and standard errors for the effect of flumequine doses in basal diet on body weightt and body length (cm) of Nile Tila is fish

Treatment	No.*	Body weight (g) (BW)		Body length (cm) B1,)	
		Initial	Final	Initial	Final
Group I	40	13.67 ± 0.41	31.73 +1.43 h	9.47 ± 0.71	11.88 ±0.33 b
Group 2	40	13.88 + 0.41	32.86 +1.43 1	9.65 + 0.71	11.99 +0.33 6
Group 3	40	13.67 + 0.41	32.58 +1.43 h	9.38 ± 0.71	11.70 :I 0.33 b
Group 4	40	13.68 1 0.41	37.57 11.43"	9.15 1 0.71	13.47 10.33'
Group 5	40	13.69 ± 0.41	31.92 11.43 b	9.21 ± 0.71	11.84 +0.33 b
Group 6	40	13.65 ± 0.41	32.72 ±1.43 b	9.17 ± 0.71	11.94±0.33 b

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

* Average of 2 replicates for each treatment.

Superscript letters arc setcd based on the actual means.

Group 1 = Control (o-flumequine)

Group 2 = Sub therapeutic doses 6 mg / kg of body weight / day during experimental period (90 days)

Group 3 = Sub therapeutic doses 8 mg / kg of body weight / day during experimental period (90 days)

Group 4 = Sub therapeutic doses 10 mg / kg of body weight / day during experimental period (90 days).

Group 5 = Sub therapeutic doses 12 mg / kg of body weight / day during experimental period (90 days)

Group 6 = therapeutic dose, 12 nig/kg of body weight / day for 5 days.

Table (11): F-ratios of least squares analysis for the effect of flumequine doses in basal diet on body weight (BW) and body length (BL) of Nile fi sh

SOY	dF	F-ratio			
		Body weight (g) (BW)		Body length (cm) (BL)	
		Initial	Final	Initial	Final
Treatment	5	0.04	3.33**	1.10	3.98**
Replicates	1	0.00	0.00	0.74	2.47
Error df	233				
Error MS		6.783	81.188	20.133	4.37

4.2.1.2. Body **length (BL):**

Average of initial body length (BL) of tilapia fish *0. niloticus* had ranged from 9.15 to 9.65 cm with non significant differences between groups (tables 10 and 11) indicating the random distribution of the fish among the treatment. Nineteen days after the experimental start, final body length (BL) had ranged between 11.70±0.33 and 13.47±0.33 cm and the difference in body length among groups were significant ($P<0.01$). Results in Table (10) indicated that the dose 10 mg/kg of body weight/day (group 4) caused longest fish bodies (13.47 cm) compared to the control group (0-flumequine) and other treatment (6, 8, 12 mg/kg body weight) with significant difference. These results are in agreement with **Azab *et* (2003) and Fath El-Bab (2006)** who found that the flumequine at dose of 10 mg/kg of bodyweight /day caused significant increase in growth rate of Nile tilapia. Also, with **Ahmed and Tan (1992)** reported that treating fishes by tetracycline caused increased body length compared to the control group.

On the other hand, these results are not in agreement with finding of **Lutzhoft *et al.* (1999)** who found inhibitory effect of flumequine on growth of fish and with ***Moutou et aL*** (2001) who reported that using flumequine as medicated diet of rainbow trout caused a decrease in growth fish.

4.2.1.3. Weight gain (WG):

Average weight gain (WG) of Tilapia fish *0. niloticus* had ranged from 18.06 to 24.64 g with significant difference between groups **($P < 0.001$)**. Results in Table (12) showed that the highest weight gain (WG) value (24.64 g) was recorded by fish fed on the

Table (12): Least square means and standard errors for the **effect of flumequine doses in basal diet on weight gain (WG) (g) and specific growth rate (SGR) of Nile Tila ia fish.**

Doses	No.	Weight gain (g) (WG)	Specific growth rate (SGR)
Group 1	**2**	18.06 ±0.36	0.93 ± 0.01
Group 2	**2**	18.98±0.36[b]	0.95 ± 0.01 [h]
Group 3	**eve**	18.92+0.36[h]	0.96 + 0.01 [h]
Group 4	**el**	24.64±0.36[a]	1.14 ± **0.01'**
Group 5	**2**	**18.34±0.36**[1)]	0.95 ± 0.01[b]
Group 6	**2**	19.07±0.36[1)]	0.97 ± 0.00

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

* Average of 2 replicates for each treatment.

Superscript letters are seted based on the actual means.

Group I = Control (o-flumequine)

Group 2 = Sub therapeutic doses 6 mg / kg of body weight / day during experimental period (90 clays)

Group 3 = Sub therapeutic doses 8 mg / kg of body weight / day during experimental period (90 days)

Group 4 = Sub therapeutic doses 10 mg / kg of body weight / day during experimental period (90 days).

Group 5 = Sub therapeutic doses 12 mg / kg of body weight / day during experimental period (90 days)

Group 6 = therapeutic dose, 12 mg/kg of body weight / day for 5 days.

Table (13): F-ratios of least squares analysis for the effect of flumequine doses in basal diet on weight gain (WG) and specific growth rate (SGR) of Nile Tila ia fish.

SOV	dF	F-ratio	
		Weight gain (g) (WG)	Specific growth rate (SGR)
Treatment	**5**	46.19***	41.11***
Error df			
Error MS		0.263	0.003

0.001)

diet contained sub therapeutic doses of flumequine 10 mg/kg of body weight/day compared with control group (0-flumequine) which showed lower weight gain (WG) (18.06g). Whereas the other doses (group 2, 3, 5 and 6) caused increases in weight gain (18.98, 18.92, 18.34 and 19.07, respectively) compared with control group. These results are in agreement with those obtained by Azab ***et aL*** **(2003)** and Fath El-Bab (2006) who found that the addition of flumequine at doses of 10 mg/kg of body weight / day in diets increased weight gain during all experimental periods of Tilapia fish. In this respect, Giebel ***et al.*** **(1982)** found that the use of flumequine out breaks of colibacillosis which resulted in beneficial effect on weight gain.

4.2.1.4. Specific **growth rate (SGR):**

Results of specific growth rate (SGR) of Tilapia fish ***0.*** *niloticus* as affected by flumequine (FLU) doses are illustrated in table (12). As shown in this table average SGR had ranged from 0.93 to 1.14 and the differences between SGR values among treatment groups were significant ($P<0.001$). The highest specific growth rate (SGR) value (1.14) was obtained with fish fed the diet contained 10mg/kg of body weight/day of flumequine compared with control group (0-flumequine) and the lowest value (0.93) was obtained with fish fed the control diet. Also the other doses (group 2, 3, 5 and 6) caused increases in specific growth rate (0.95, 0.96, 0.95 and 0.97, respectively) but with in significant difference as compared to control group. These results are in agreement with **Fath El-Bab (2006)** who found that flumequine at dose of 10 mg/kg of body weight / day caused significantly increase in specific growth rate of Nile tilapia at the all experimental periods studied.

In this respect, **Azab** ***et aL*** **(2003)** found that flumequine at dose of 10 mg/kg of body weight / day resulted in significant increase in growth rate of tilapia fish.

Brander ***et aL*** **(1993)** and **Lutzhoft** ***et al.*** **(1999)** stated that, addition of flumequine to diets can improve SGR.

On the other hand Moutou ***et aL*** **(2001)** reported that using flumequine as medicated diet in rainbow trout caused decrease in specific growth rate.

4.2.2. Feed utilization:

With regard to the effect of flumequine levels on feed intake (FI), feed conversion ratio (FCR) and protein efficiency ratio (PER) of Nile tilapia, results of Tables (14 and 15) showed that the highest feed intake.(43.56 g/fish) was recorded for fish fed diet 10 mg/kg of body weight / day of flumequine compared with control group (0-flumequine) and the other doses (group 2, 3, 5 and 6) caused significant ($P < 0.05$) increase in feed intake (41.04, 41.44, 42.84 and 41.96 g, respectively). In significant improved feed conversion ratio (1.62) was observed with the dose 10 mg/kg of body weight / day whereas the other doses caused non significant change in feed conversion ratio (FCR) compared with control group. Analysis of variance (table 15) indicate that the differences among values of FCR during the whole period were in significant. These results indicate that, the addition of flumequine in tilapia diets may improve the feed conversion ratio during the whole experimental period.

Table (14): Least square means and standard errors for the effect of flumequine doses in basal diet on feed

Doses	No.*	Feed intake (g) (FI)	Feed conversion ratio (FCR)	Protein efficiency ratio (PER)
Group 1	**2**	36.08±1.22[b]	1.73±0.15	1.67±0.07
Group 2	**2**	41.04±1.22[a]	1.93±0.15	1.73±0.07
Group 3	**2**	41.44±1.22[a]	1.67±0.15	1.65±0.07
Group 4	**2**	43.56±1.22[a]	1.62±0.15	1.95±0.07
Group 5	**2**	42.84±1.22[a]	1.93±0.15	1.73±0.07
Group 6	**2**	41.96±1.22[a]	1.71±0.15	1.79±0.07

Means with the same letters in each column arc not significantly di I ferent.

* Average of 2 replicates for each treatment.
Superscript letters are seted based on the actual means.
Group 1 = Control (o-flumequinc)
Group 2 = Sub therapeutic doses 6 mg / kg of body weight / day during experimental period (90 days)
Group 3 = Sub therapeutic doses 8 mg / kg of body weight / day during experimental period (90 days)
Group 4 = Sub therapeutic doses 10 mg / kg of body weight / day during experimental period (90 days).
Group 5 = Sub therapeutic doses 12 mg / kg of body weight / day during experimental period (90 days)
Group 6 = therapeutic dose, 12 mg/kg of body weight / day for 5 days.

Table (15): **F-ratios of least squares analysis for the effect of flumequine doses in basal diet on feed utilization of Nile Tila ia fish.**

SOV	df	F-ratio		
		Feed intake (FI)	Feed conversion ratio (FCR)	Protein efficiency ratio (PER)
Treatment	5	6.48*	0.59	1.95
Error df	6			
Error MS		2.965	0.051	0.012

*** = (P <** 0.05)

Results of protein efficiency ratio (PER) also showed that the best value (1.95) was recorded by fish fed diet 10 mg/kg of body weight / day and the other doses had no effect on PER compared with control group and the differences between protein efficiency ratio values due to effect of the treatments were in significant (Table 15).

These results are agreement with Azab *et al.* (2003) who found that flumequine at dose of 10 mg/kg of body weight / day caused a significant increase in protein efficiency ratio and improvement in feed conversion ratio compared to control fish group. Also, with results obtained are in agreement the finding of **Fath El-Bab (2006)** who reported that, the addition of flumequine in Tilapia diets improved the feed conversion ratio and the protein efficiency ratio during the experimental period and the differences in FCR and PER among as treatments affected by different treatments were in significant.

Gieble *et al.* **(1982)** found that the use of flumequine in out breaks of colibacillosis had beneficial effect on feed consumption.

On the other hand, **Mouton** *et al.* **(2001)** investigated the effect of flumequine on individual consumption rates and growth of juvenile rainbow trout. They reported in significant changes in the feed consumption in groups of rainbow trout when flumequine was supplemented in high concentrtion. Also, **Tarter (1986)** reported that the nalidixic acid or sodium oxolinate in therapeutic doses not effect on food, water consumption, feed conversion rate and body weight of chickens.

4.2.3. Proximate analysis of fish flesh body :

The chemical analysis of fish flesh for moisture, protein, lipids and ash percentages was routinely conducted on experimental fish at the end of feeding experiment.

Results in Table (16) indicated that, averages of moisture content of Tilapia flesh as affected by flumequine level (6, 8, 10, 12 mg/kg of body weight/day for three month and therapeutic dose 12 mg/kg of body weight/day for 5 days in fish diets) were 77.11, 76.54, 76.13, 76.80 and 76.63% and the differences between these percentages were in significantly however values of moisture contents tended to decrease compared with control group. On the other hand increases in protein content in fish flesh from 67.19 to 67.25, 67.20, 67.34, 67.31 and 67.21% were observed in groups with flumequine at levels 6, 8, 10, 12 mg/kg of body weight / day for three months and therapeutic dose 12 mg/kg of body weight/ day for 5 days in fish diets, respectively, and the differences between these percentages were in significant compared with control group (0-flumequine).

Fat contents significantly ($P < 0.01$) decreased from 13.26 (control group — 0 flumequine) to 12.69, 11.87, 11.13 11.80 and 11.89% in groups 2, 3, 4, 5 and 6 respectively (Tables 16 & 17). Also ash content decreased from 16.67 in control group to 16.30, 16.28, 16.03, 16.20 and 16.38% in groups 2, 3, 4, 5 and 6 respectively.

In general the fish and diets containing 10 mg/kg dose of body weight/day gained the highest percentage of protein (67.34%) and the lowest percentages of moisture (76.13%), fat (11.13%) and ash (16.03%) in fish flesh compared with other doses ratios.

Table (16): Least square means and standard errors for the effect of flumequine doses in basal diet on chemical composition of whole Nile Tilapia fish body.

Doses	No.*	Moisture %	Protein %	Fat %	Ash %
Group 1	6	7735+0.063	67.19+1.10	13.26+0.60a	16.67+0.55
Group 2	6	77.11±0.063	67.25+1.10	12.69±0.60a	16.30+0.55
Group 3	6	76.54+0.063	67.20+1.10	11.87+0.60	16.28±0.55
Group 4	6	76.13+0.063	67.34+1.10	11.13+0.60	16.03+0.55
Group 5	6	76.80+0.063	67.31+1.10	11.80+0.60[1]	16.20+0.55
Group 6	6	77.50+0.063	67.21+1.10	11.89+0.60	16.38+0.55

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

* Average of 2 replicates for each treatment.

Superscript letters are seted based on the actual means.

Group 1 = Control (o-flumequine)

Group 2 = Sub therapeutic doses 6 mg / kg of body weight / day during experimental period (90 days)

Group 3 = Sub therapeutic doses 8 mg / kg of body weight / day during experimental period (90 days)

Group 4 = Sub therapeutic doses 10 mg / kg of body weight / day during experimental period (90 days).

Group 5 = Sub therapeutic doses 12 mg / kg of body weight / day during experimental period (90 days)

Group 6 = therapeutic dose, 12 mg/kg of body weight / day for 5 days.

Table (17): F-ratios of least squares analysis for the effect of flumequine on chemical composition of whole Nile Tilapia fish body.

SOV	df	F-ratio			
		Moisture	Protein	Fat	Ash
Replicate	1	0.018	0.333	2.000	1.74
Treatment	5	1.995	1.0117	10.001**	0.451
Reminder df	29				
Reminder ms		3.3490	86.8019	30.345	1.4443

**=P <0.01

In this respect, **Choubert *et aL* (1991)** found that supplementing the high- lipid diet with antibiotics increased ($P<0.01$) lipid, carbohydrate and total energy in rainbow trout, bodies but not that of crude protein.

4.2.4. Determination of flumequine residues in tissues:

Flumequine residues in muscle were determined at the end of the experiment after three month. Results of flumequine residues in tilapia fish at Table (18) show that all samples revealed negative results.

These results are in agreement with **Chomel *et aL* (1983)** in rainbow trout who found that no residues of flumequine were found 48 hours after stopping the treatment. Also results of table (18) are in agreement with those of **Liu-Chew-King (1992)** who found negative results for residues flumequine of gaint tiger prawn and kuruma prawn.

Azab *et aL* (2003) who detected flumequine residues in fish tissue until 10 and 20 days after last feeding in group administered 10 mg/kg of body weight, whereas fish administered 6 mg/kg of body weight / day, flumequine was not detected after 10 days of last feeding.

On the other hand, **Chevalier *et aL* (1981)** found that flumequine residues were detect in fish tissue until 48-72 hours after oral therapy with 6-12 mg/kg fish / day for 5 days. **Steffenak *et aL* (1991)** found that residues of flumequine were present in the fish for prolonged periods after the end of treatment.

Table (18): Flumequine concentration in muscle of Tilapia fish.

Fish group	Flumequine residues after 3 months	in fish muscle
	Muscle	`)/0
Group 1	0	()
Croup 2	0	0
Group 3	0	0
Group 4	0	0
Group 5	0	0
Group 6	0	0

Group 1 = Control (o-flumequine)

Group 2 = Sub therapeutic doses 6 mg / kg of body weight / day during experimental period (90 days)

Group 3 = Sub therapeutic doses 8 mg / kg of body weight / day during experimental period (90 days)

Group 4 = Sub therapeutic doses 10 mg / kg of body weight / day during experimental period (90 days).

Group 5 = Sub therapeutic doses 12 mg / kg of body weight / day during experimental period (90 days)

Group 6 = therapeutic dose, 12 mg/kg of body weight / day for 5 days.

Comparative kinetic and residues studies were carried out by Della-Rocca *et aL* (1996) in sea beam *(Sparus aurata)* following in-feed administration of oxytetracycline (OTC: 75 mg/kg b.w./day for 14 days) or flumequine (FLU: 12 mg/kg b.w/day for 5 days). They found that OTC concentrations were higher in liver, skin and bone than in muscles and most persistent in muscle and bone. However FLU, always present at concentration lower than those of OTC, showed a persistence in bone and skin longer than in liver and muscles. Also, **Malvis** *et aL* **(1997)** evaluated the tissue distribution and depletion times of flumequine a quinolone derivative in sea bream *(Sparus auvata)* after in-feed administration for 5 days (12 mg/kg b.w./day). They found that the highest concentrations were recorded in vertebrae and skin collected 24 h after treatment. While at the same time flumequine disappeared from muscles 240 h after treatment ceased and showed a longer depletion mate from skin and vertebrae, which behaved as reservoir tissues. In this respect, **Posyniak** *et al.* **(1999)** investigated the absorption and elimination of flumequine in liver and muscle tissue of juvenile carp. They found that the highest levels of flumequine were obtained in livers within 2nd day after i.p. administration (10 mg/kg). After oral treatment with 20 mg/kg, the maximum levels were measured in livers within 28h. The elimination half-lives in muscle and liver tissue were 16.4 and 22.2 h after oral dosing and 28.6 and 34.3 h, after i.p. administration, respectively.

4.2.5. Cytogenetic studies:

The normal chromosome number of tilapia fish were 44 chromosomes (22 chromosome pairs). The first and second pairs

are of conspicuous size, especially the first one which is larger pairs (throught to be the marker chromosome) the other twenty pairs are small with short arms and gradually decrease in size **(Thompson, 1979; Arai and Koike, 1980; McAndrew and Majamdar, 1984 and Crosetti *et al.,* 1988).**

Table (19) showed the average of chromosomal abnormalities observed in kidney cells of fishes treated with different doses of flumequine. Also, Figures was 1, 2, 3, 4 and 5 showed the structure of normal chromosome and types of aberrations (deletion, ring, centromeric attenuation & centric fusion, break and gap) respectively.

The results of the Table (19) showed that, flumequine at dose of 10 mg / kg of body weight / day caused significant decrease in total chromosomal aberrations compared with other doses and significant increase compared with control group. It can be observed that, flumequine at dose of 10 mg / kg of body weight / day caused significant increase in chromosomal aberrations over the control cells with deletion, end to end ($P < 0.01$) and sticky ($P < 0.05$) and the value percentage in total chromosomal aberrations were 5.79%. whereas flumequine in close 6 mg / kg of body weight / day caused significant increase in chromosomal aberrations with deletion, Ring, centromeric attenuation, centromeric fusion, cromatid gab, end to end, sticky. The value percentage aberrations were 8.32% and flumequine in dose 8 mg / kg of body weight / day caused significant increase with deletion, ring, centromeric attenuation, end to end, sticking and the value percentage in total chromosomal aberrations were 7.52%.

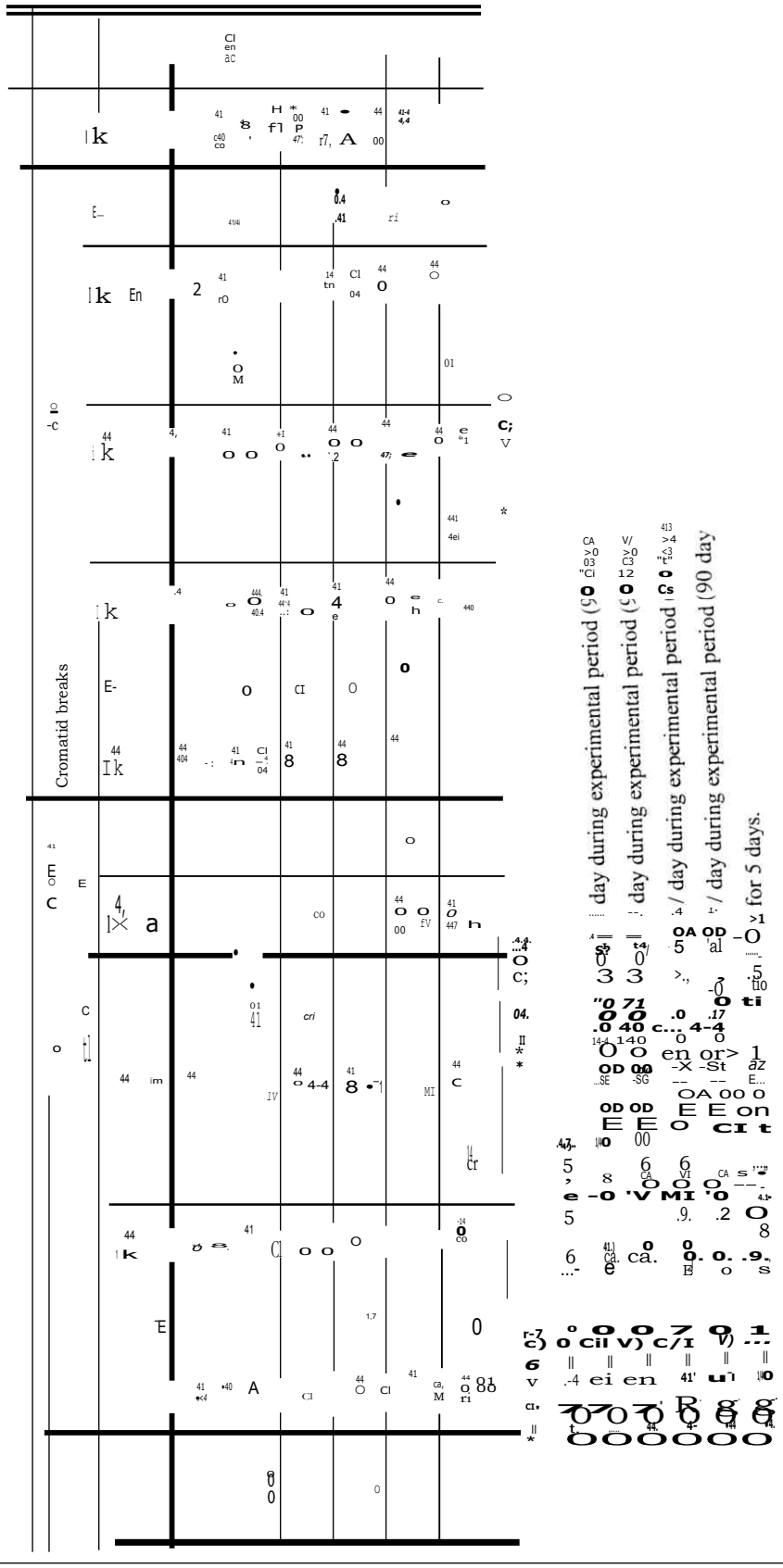
Cromatid breaks
day during experimental period
day during experimental period
/ day during experimental period
/ day during experimental period (90 day
for 5 days.

Fig. (1): A metaphase spread of Tilapia fish exposed to flumequine at dose 10 mg/kg of body weight / day (arrow indicates chromatid deletion).

Fig. (4): A metaphase spread of Tilapia fish exposed to flumequine at dose 10 mg/kg of body weight / day (arrow indicates chromatid break).

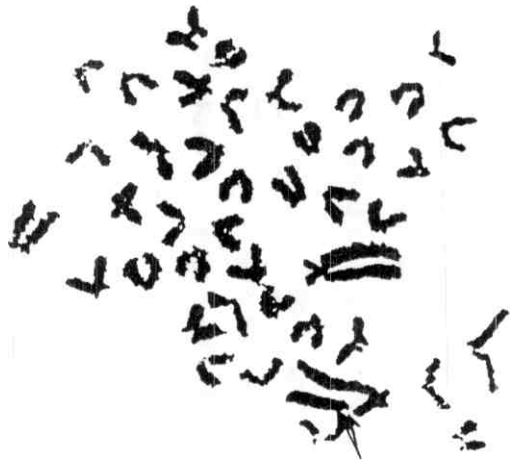

Fig. (5): A metaphase spread of Tilapia fish exposed to flumequine at dose 10 mg/kg of body weight / day (arrow indicates chromatid gap).

The dose 12 mg/kg of body weight caused significant increase in deletion, centromeric attenuation, centromeric fusion, cromatid gab, end to end, sticky and the value percentage in total chromosomal aberrations were 8.7%, whereas therapeutic dose 12 mg/kg of body weight caused significant increase in chromosomal aberrations with deletion, Ring, centromeric attenuation, cromatid gab, end to end, sticky and the value percentage aberrations were 8.75%.

These results are in agreement with **Azab** *et al.* **(2003)** who found that flumequine at dose of 10 mg/kg body weight/day caused significant increase in total chromosomal aberration compared with control group of Nile tilapia.

On the other hand, **Obe** *et aL* **(1982)** reported that DNA is the primary target for the induction of chromosomal damage. **Toranzo** *et aL* **(1987)** found that flumequine, oxolinic acid, oxytetracycline and chloramphenicol and highly resistant ampicillin. Although the extracellular products from the vibrio isolates displayed strong cytotoxic activity on the five fish cell lines tested, a non pathogenic reference strain also showed a positive toxic effect.

Salem (1997) found that, deletion hypoloid and ring chromosomes occurred more frequently, while stickiness of fragment were less frequent in *Oreochrornis aureus* fish, he showed also that deletion, ring chromosomes and fragment were most frequent types of chromosomal aberrations in *Tilapia zillii* fish, when exposed to copper pollution in Nile Delta.