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STUDY ON SOME FACTORS AFFECTING ON GROWTH OF FISH

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ABSTRACT: Nile tilapia (*Oreochromis niloticus*), fingerlings (average initial weight 19.1-22.99 g) were raised in 36 seventy five -L glass aquariums (litter each) at stocking density of 10 fish per aquarium for 20 of weeks after adaptation period (15 day). The fish were fed daily at 3% of its life body weight in four feeding times per day (8.00 and 11.00 am, 2.00 and 5 pm). Combined effects of dietary protein levels (30 or 35%), water temperature (22, 28, 32°C) and water salinity (0.3 and 15 ppt) were studied. In addition, whole fish, flesh analysis, blood components, water quality and survival rate were investigated. Final mean weights were significantly (P<0.001) higher at 32 and 28°C than 22°C at 15 ppt salinity within all dietary protein levels (30 or 35%). Where fish weights increased by increasing all these factors and their interactions. Also, feed conversion efficiencies were high at 32°C and 15 ppt salinity and 35% dietary protein. In both dietary protein levels, growth increased with increasing temperature and salinity. At water temperature 32°C and slinity 15 ppt the lowest survival rate were 36.67 and 43.33% for groups fed diets containing 30 and 35% crude protein, respectively. Therefore, the study suggested that growth rates of *O.niloticus* fingerlings and their survival rate may be best at 35% dietary protein level, 28°C and 15 ppt.

INTRODUCTION

Fish can a quire nutrients by consuming various products of plants and animals, microbial and mineral origins. In nature, fish obtain nutrient from various types of food items, these being determined both by the feeding performance of the animal and the items availability in the environment. The dietary protein requirements of several tilapia species have been estimated to range between 20% and 56% (El-Sayed and Teshima, 1991). Most studies are confined on young tilapia, although the major part of the feed is used during the grow-out period (Siddiqui, *et al.*, 1991). Therefore, it is also important to know the optimum dietary protein requirements of larger tilapia during the grow out phase under different conditions.

Generally, the process of fish growth is affected by many factors such as food, temperature, light, age, space, etc. Among these factors, the relationship between feed consumption and growth is on of considerable importance and is necessary found foundation for the development of fish culture. However, the amount of consumed food contributes to actual growth. Feeding level and composition of the complete diets are determined nutritional requirements (Likongwe, *et al.*, 1996).

It is also, important to know that Nile tilapia *Oreochromis niloticus* (Linne) is one of the most important fresh water finfish in aquaculture. It grows fast but is less salt-tolerant than *Oreochromis aureus* (steindachner) (Watanabe, *et al.,* 1985 and Avella, *et al.*, 1993) *Oreochromis mossambicus* (peters) and *Tilapia zillii* (Gervais) (Stickney, 1986). But Suresh and Lin (1992), showed that both *O. niloticus* and *O. aureus* are suitable for low salinity brackish water. However, very little information on the tolerance of Nile tilapia to salinity except the work of Watanabe, *et al.* (1993) who showed that salinity modified the effect of water temperature on Florida red tilapia growth. Tilapia is known to tolerate high water temperatures, but salinity has been reported to modify temperature effects on growth (Stauffer, *et al.*, 1984) and temperature may also influence salinity selection (Miller, *et al.*, 1983). In nature, temperature and salinity may fluctuate together and considering the wide range of habitats that are used world wide to raise *O. niloticus* commercially. It is important to understand the interactive influence of water temperature and salinity on growth and feed utilization of this fish.

Therefore, the aim of the present experiment is to study the effect of different water temperature, salinity and protein level on growth performance, feed utilization, body composition and survival rate of *Oreochromis niloticus* fingerlings.

MATERIAL AND METHODS

The present study was carried out at the Department of Animal Production, Faculty of Agriculture, Zagazig University, in cooperation with Zagazig and Gimeza Station, Animal Production Research Institute, Cairo, Egypt.

3.1. Design:

The fish were randomly divided into two groups each received one of two dietary protein levels (30 or 35%). Each protein group had six treatments, each three replicates (aquarium). Fish groups were conditioned under the following conditions:

Three water temperatures:

a) Laboratory temperature (22°C).

b) 28°C.

c) 32°C.

Two salinity levels:

a) Laboratory water salinity (0.3 ppt).

b) Higher water salinity (15 ppt).

3.2. Experimental procedures:

3.2.1. Preparation of the aquariums :

The glass aquariums (75 liters each) were supplied with filters thermostatic heaters, thermometers and air stones connected to air pumps wheres 24 aquariums were filled with water from [1m^3] tank by one thermostatic heater.

3.2.2.Preparation of the water salinity and temperature:

Salt obtained by dissolving row salt to the water until attained the corresponding level. Water temperature was adjusted at two levels (28 and 32°C) by thermostatic heaters.

3.2.3. Water quality:

Water samples were taken biweekly before replacing 25% of the aquarium water for analysis of ammonia (NH_4) nitrate (NO_3) and nitrite (NO_2) in Unit of Analysis & Studies, Soils, Water & Environment Research Institute, Agricultural Research Center Ministry of Agriculture.

The water salinity, conductivity (Cond) total dissolved solids (TDS) and temperature (°C) were measured daily at 8.00 am 2.00 and 8.00 pm by using cond TDS/Salinity-Temp Meter Orion

Mod 115 as µs or ms, mg/l and ppt,°C, respectively. At the same time, the oxygen level (ppm) and saturation (%) was measured by AS 401 Oxygen Meter. The pH values were determined twice weekly by digital pH meter Jen CO. Electronics LTD Mod. 6007.

The analysis of saline water (row salt) quality. Composition of salt used. Whereas, fresh water description. Average measurements of water quality are.

3.2.4. Acclimatization of fish:

The fish were transferred from El-Kanater El-Khairia area to the laboratory in aerating tanks. To acclimate the fish to normal laboratory conditions it was left for 24 hours without feeding. The fish were acclimated to water salinity and temperature by gradual raise of salinity levels (3.0, 6.0, 9.0…..ppt) and temperature degree (24, 26, 28…°C) before starting the experiment.

3.2.5. Feeding system:

During the experiment, fish were fed diets described in Table (1). The fish were fed daily at a rate of 3% of fish life body weight. The fish were fed four time daily at 8.00, 11.00 am, 2.00 and 5.00 pm.

3.2.6.Maintenance of aquarium:

Cleaning the aquarium is very important in rearing fish. Fish faeces and feed residuals were removed by using plastic tube. About 25% of the water in the aquarium were replaced by aerated fresh water every two days. Checking up water salinity temperature and the function of the pump aerators was routinely carried out every day.

3.3. Measurement of growth and feed utilization parameters:

During the experiment the fish were weighted individually to the nearest gram at the beginning of the experiment and then biweekly intervals throughout the experimental period.

Weight gain average daily gain (ADG), feed conversion ratio (FCR) and Protein efficiency ratio (PER) were calculated according to the following equations.

3.3.1. Live body weight gain

Fish were weighed to the nearest 0.1 g at the beginning of the experiment and every 15 days and the amount of feed given was adjusted in accordance with the measured biomass. Live body gain was calculated by subtracting the two successive live weights at different experimental periods.

ADG = Average weight gain (g)/ ex. Period [d]

3.3.2. Feed utilization:

The feed conversion ratio (FCR) is expressed as the proportion of dry food fed per unit live weight gain of fish.

FCR = Feed intake (g) / Weight gain (g)

3.3.3. Protein utilization:

The protein efficiency ratio (PER) gives the measure of the efficiency of dietary protein utilization by fish. PER calculated as the live weight gain of fish per gram of crude protein fed.

PER = Live weight gain (g)/ Protein intake (g)

3.4. Chemical analysis of diets and fish carcass:

Fish samples were taken from each aquarium for chemical analysis at the start and the end. All the samples were prepared for whole and flesh chemical analysis. The samples were mixed in mixer and dried at 65°C overnight.

Moisture, crude protein (CP), ether extract (EE), crude fiber (CF), and ash content of the experimental diets and fish body compostion were determined according to the method of A.O.A.C. (1984).

3.5. Physiological parameters:

At the start and the end of the experiment, blood samples were taken from gill arch of 5 fish aquarium by syringe using heparin as an anticoagulant. The blood samples were centrifuged at 4000 RBM for 15 Minutes to separate the serum. The collected serum were stored in deep freeze at –20°C for analysis.

Total protein, albumin and aspartate amino transferase (AST) and alanine amino transferase (ALT) were determined calorimetrically by transaminases kites (Boehringer Manmheim kit).

3.6. Economical evaluation:

Economical evaluation of the the experimental data has been done from of the cost (LE) of one kg fish weight gain produced.

3.7. Statistical analysis:

The effects of protein water salinity and temperature were analyzed by factorial analysis of variance designe (Snedecor and

Cochran 1982) according the following model.

Yijk = M + Pi + Sj + Tk + Ps + Ptik + PSTijk + Eijki

Where Y is the overall mean p, is the fixed effect of dietary protein level (i = 1..2) s is the fixed effect of j th water salinity (j = 1….2), Tk is the fixed effect of kth water temperature (K = 1….3) PSij is the interaction effect of ith dietary protein level and jth water salinity ptik is the interaction effect of ith dietary protein level and kth water temperature stjk is the interaction effect of jth water salinity and kth water temperature PST ijk is the interaction effect of ith dietary protein level jth water salinity and kth water temperature and Eijki is the random error.

Mean were tested for significant differences by using Duncan's Multiple Range test (Duncan, 1955).

RESULTS AND DISCUSSION

1. Growth performance:

Live body weight (g) of Nile tilapia was affected significantly ($P<0.001$) by dietary protein level in all the experimental periods (Fig. 1). Santiago, *et al.*, (1985) reported better growth in adult Nil tilapia fed 40% protein than in fish fed 20% protein diet. Chang, *et al.*, (1988) also, reported better growth in adult red tilapia (231-242 g) fed a high protein (44%) diet rather than low protein diets (21% and 27%).

Growth was lowest at low temperature, indicating low temperature detrimentally affected metabolic rate and implies that energy expenditure for osmoregulation may have occurred at the expense of growth (Likongwe, *et al.*, 1996).

Generally, growth increased with increasing dietary protein level, water temperature and salinity. Daily body gain weight was significantly ($P<0.001$) affected by dietary protein level, water temperature and salinity (Fig. 2). Similar results were reported by Buentello, *et al.* (2002), Baras, *et al.* (2001) and Martinez-Palacios, *et al.* (2002).

2. Feed utilization:

All experimental period the results showed that daily feed intake and efficiency feed conversion increased significantly ($P<0.001$) with increasing dietary protein level, water temperature and salinity and their interaction (Figures 3 and 4). Won, *et al.* (1995) reported that the improvement in feed conversion rate was achieved when dietary protein level increased.On the other hand, feed conversion ratio (FCR) increased with increasing fish weight and decreased with increasing dietary protein level (Al Hafedh, 1999).

Fish fed high protein diet (35%), high water temperature (32°C), saline water (15 ppt), recorded better feed conversion when compared with the other experimental groups.

3. Blood component:

Blood total protein, albumin and alanine amino transaminase (Alt) were significantly (P<0.001) affected by dietary protein level, water temperature, salinity and their interaction (Fig. 5). These results may indicated that the protein synthesis increased in fish body by increasing water temperature and salinity. This findings are in agree with the results of Handeland, *et al*. (2000) who found that GH level decreased during long-term adaptation in the 4, 6, 9.1 and 14.4°C groups, whereas a significant increase (P<0.05 or 0.001) was observed in the 18.9°C group.

The concentration of asaparate amino transferase (AST) decreased significantly (P< 0.0001). These results may indicate that protein synthesis increased in fish body by increasing each of dietary protein level and water temperature and salinity.

4. Body composition:

The study showed that whole body conpostion and fish flesh were affected significantly (P<0.01 or 0.001) by water temperature and salinity and their interaction. Curde protein, ether extract and ash content of the whole body of fish affected significantly (P<0.001) with the interaction between dietary protein level and water temperature and salinity, while dry matter content insignificantly affected.

Dry matter and ash content of the flesh were affected significantly (P<0.001) with interaction between dietary protein level and water temperature and salinity. Within each dietary protein level, increasing water temperature and salinity increased the content of dry matter, crude protein and ether extract of the fish muscles (Figures 6 and 7).

5. Water quality:

Fish culturists are more concerned with those aspects of water quality, which regulate the suitability of water for rearing fish.

Dissolved oxygen was measured daily. It is clear that the highest level was (7-6-8.7 ppm) at laboratory temperature (22°C) and the lowest was (5.8 ppm) at high temperature (32°C). There is negative correlation between water tempreature and disolved exygen. The pH values were determined twice weekly, it was observed that the pH values were lower (6.30 - 6.78) at fresh water (0.3 ppt) than (7.05-7.22) at salinity water (15ppt).

Total dissolved solids (TDS) was the lowest (340.75-343.50 mg/1) at fresh water (0.3ppt) and the highest (16633.33-16766.67 mg/1) at salinity water (15 ppt). Conductivity results was decreased with increasing water salinity. It ranged between 29.59 ms to 714.75 µs at salinity water (15 ppt) and fresh water (0.3 ppt), respectively (Tables 2, 3, 4 and 5).

It is clear that there were difference between treatments through one period (1 month). It showed that ammonia (NH4) of aquarium contained 15 ppt row salt was higher (1.253 ± 0.239) than of fresh water (0.3 ppt) (0.607± 0.115) through out the first month (1m). Total ammonia developed more rapidly in salt-water then in the controls (<0 gl-1 salinity) (Likongwe *et al.*, 1996). It is important that the toxicity of unionized ammonia is affected by pH, temperature salinity, life stag, fish size, fish species, dissolved oxygen, calcium, and carbon dioxide concentration (Meade 1985 and Russo 1985).

The ammonia level at the start of the experiment was higher than at the end this may due to the faster growth rate observed at starting of experiment than at the end. Similar results were observed by Yu and Perimutter (1970) who concluded that ammonia was hot involved in growth suppression of crowded fish, because the ammonia was more concentrated in the treatment with the fastest growth rate.

The concentration of nitrite (No2) was decrease from (0.090 ± 0434 - 3.850 ± 0.872) to (0.280 ± 0.140 - 1.043 ± 0.348) for the first month and the five months, respectively. Concentration of nitrate was highest among the second month compared with the other months.

Survival rate:

The highest survival was 96.67% for the control (22°C and 0.3ppt) and 100% for other treatments. Likongwe, *et al.* (1996) reported that the lowest survival was 36.67 for fish fed 30% protein and increased to 43.33% when fish were fed 35% protein diet under condition 32°C and 15 ppt (Fig. 9). The high temperature (32°C) decreased oxygen level in water combined with elevated water salinity (15 ppt) may led to died of Nile tilapia. The interaction between two or more ecological factors can modify the effect of factors acting individually (Kutty *et al.*, 1980).

CONCLUSION

The study suggested that generally a combination of 30 or 35% protein level with water temperature 28°C and 15 ppt gave the best results compared with the other groups where growth, feed utilization and survival rate were maximum. Worldwide Nile tilapia is raised under wide variety of environmental conditions and further studies are needed to understand the combined effects of dietary protein level water temperature and salinity on growth of *O. niloticus* and other tilapia species.

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Table (1): Formulation of the diets.

Ingredients	Low protein level (%)	High protein level (%)
Fish meal	15.00	22.00
Soya bean meal	38.0	40.00
Yellow corn	30.00	25.00
Wheat brain	10.50	6.50
Corn oil	6.00	6.00
Vit Minerals Mix	0.50	0.50
Total	100	100

Table (2): The analysis of saline water used in the experiment.

	PPM			PPM					
	NO_3	NH_4	NO_2	Cu	Mn	Fe	Zn	K	P
Saline water (row salt)	0.54	0.0	0.0	0.024	0.074	0.047	0.041	0.280	0.868

Table (3): Components of the salt used in the experiment.

Component	%
Sodium chloride	78%
Magnesium chloride	11.00
Calcium sulphat	3.50
Magnesium sulphat	4.70
Potassium sulphat	2.30
Rest	0.5

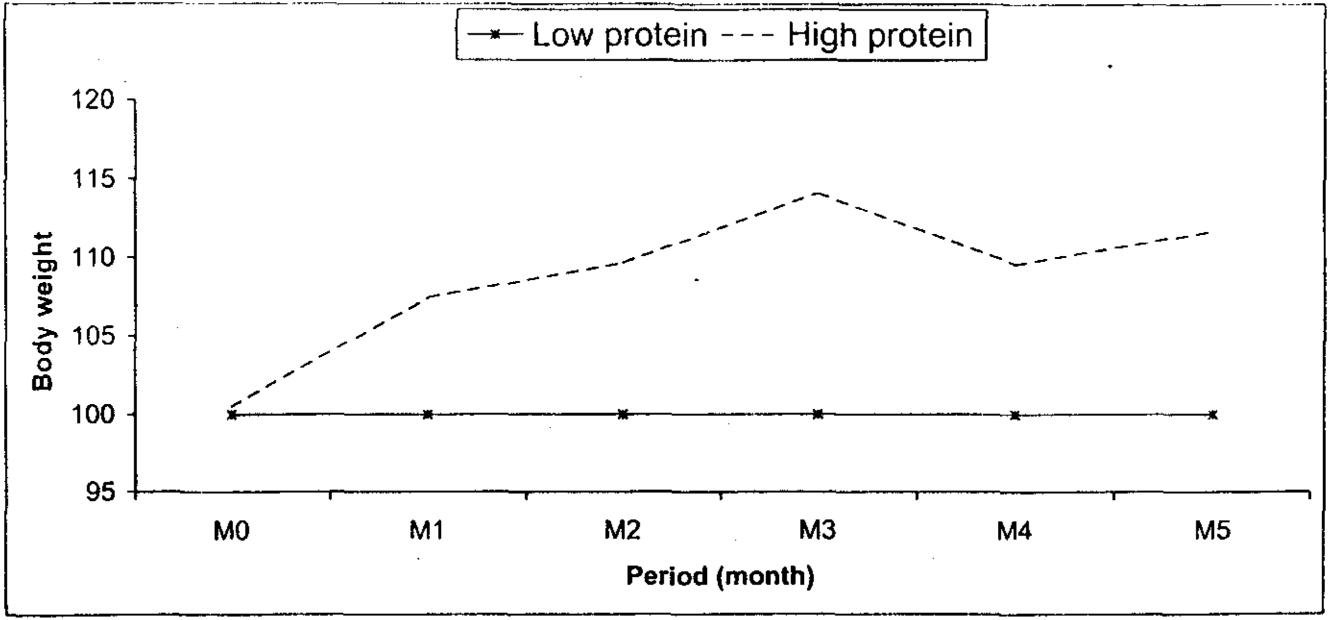
Table (4): The quality of the fresh water used in the present experiment.

Laboratory water	Salinity ppt	Temp (°C) winter	TDS mg/l	Cond µs	Oxygen ppm	pH
	0.3	21.0 - 23.4	329	683	8.2 - 8.6	7.9 - 8.84

Table (5): The average daily measurements of water parameters through experimental period.

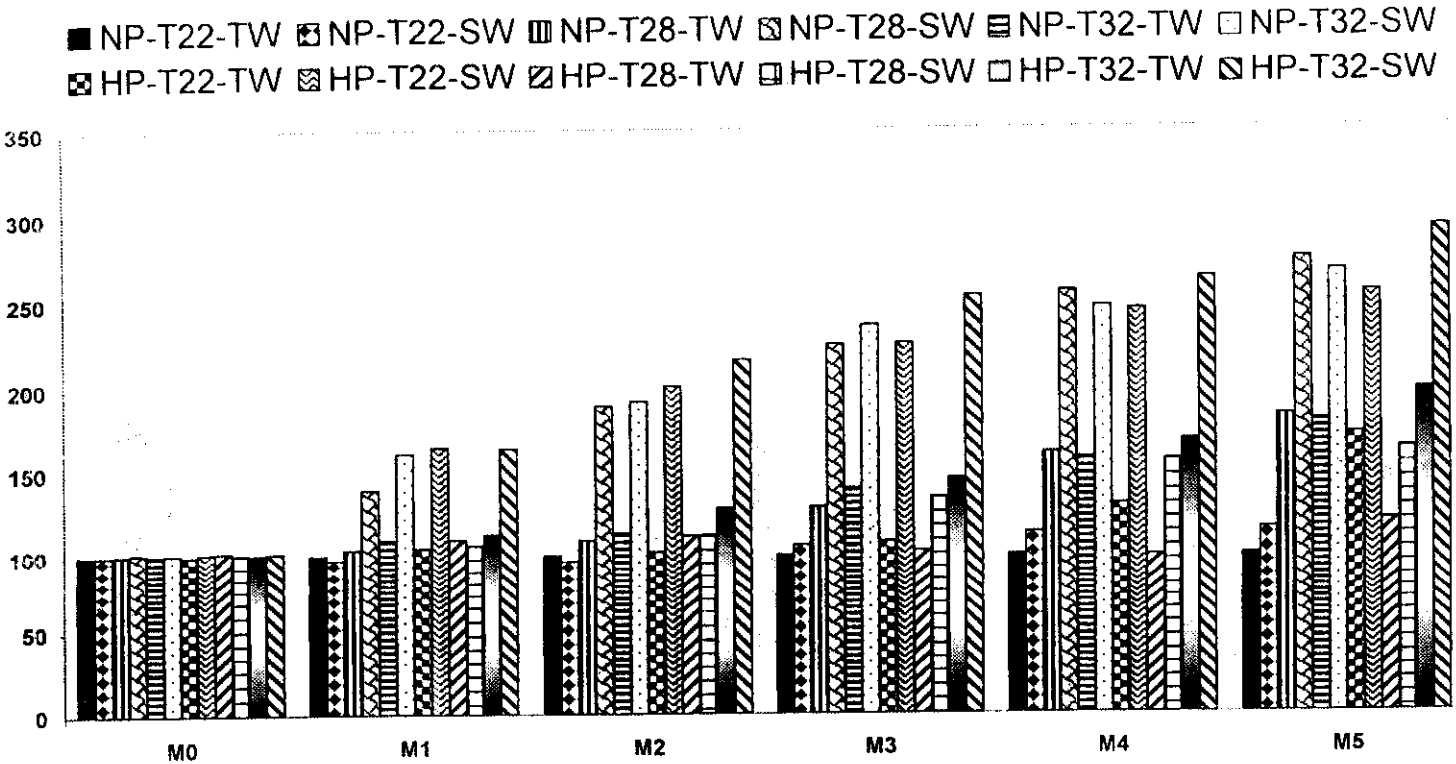
No	Salinity (ppt)	Temp Winter Season	Oxygen (ppm)	pH	Cond µs or ms	TDS mg/1
1	0.3	21.0	8.65	6.30	711µs	340.75
2	15.0	24.35	7.6	7.22	29.68 ms	16766.67
3	0.3	28.2	6.8	6.78	713µs	341.25
4	15.0	28.1	6.9	7.05	29.28 ms	16766.67
5	0.3	32.2	6.8	6.38	720.25µs	343.5
6	15.0	32.0	5.8	7.09	29.8 ms	16633.33

Figure 1. Body weight index of Nile tilapia fish as affected by dietary protein level*.



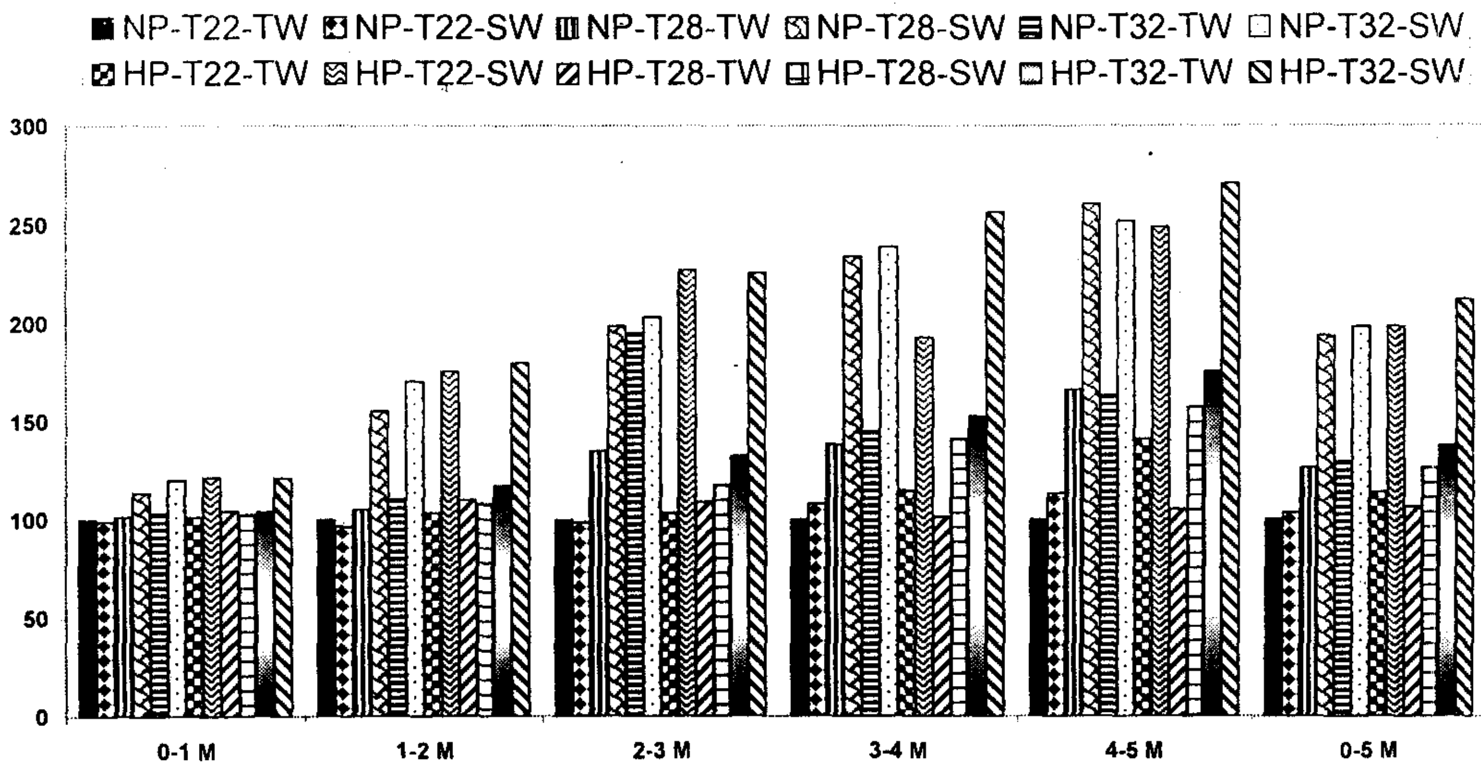
* Considering the values of fish fed normal protein diet as 100%

Figure 2: Body weight index of Nile tilapia fish as affected by dietary protein level, water temperature and salinity*.



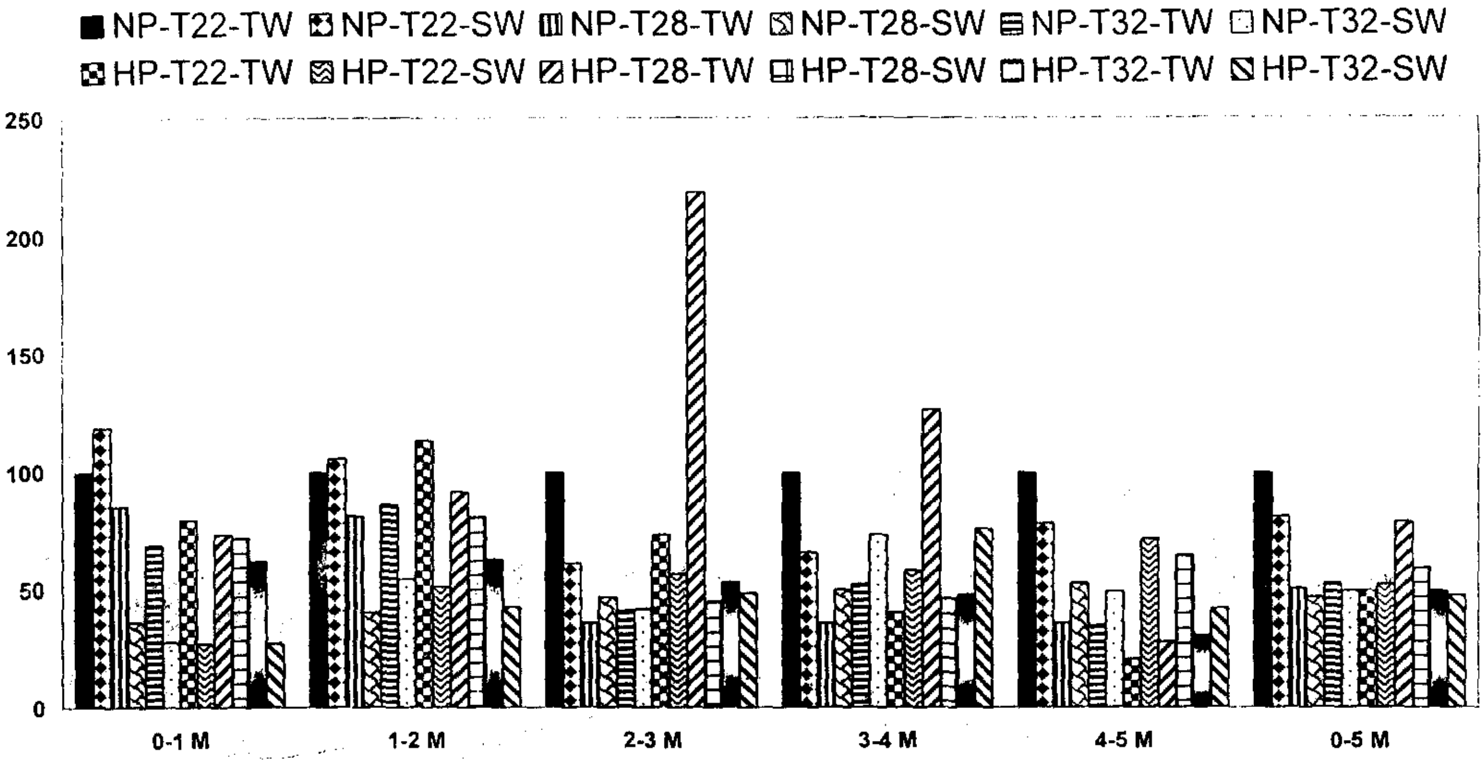
* Considering the values of fish fed normal protein diet (at 22°C and on 0.3 ppt salinity) as 100%.
M = Month = 4 weeks

Figure 3. Daily feed intake index of Nile tilapia fish as affected by dietary protein level, water temperature and salinity*.



* Considering the values of fish fed normal protein diet (at 22°C and 0.3 ppt salinity) as 100%.
M = Month = 4 weeks

Figure 4: Feed conversion index of Nile tilapia fish as affected by dietary protein level, water temperature and salinity*.



* Considering the values of fish fed normal protein diet (at 22°C and 0.3 ppt salinity) as 100%.
M = Month = 4 weeks

Figure 5: Blood components index of Nile tilapia fish as affected by dietary protein level, water temperature and salinity and their interaction at the end of experiment.

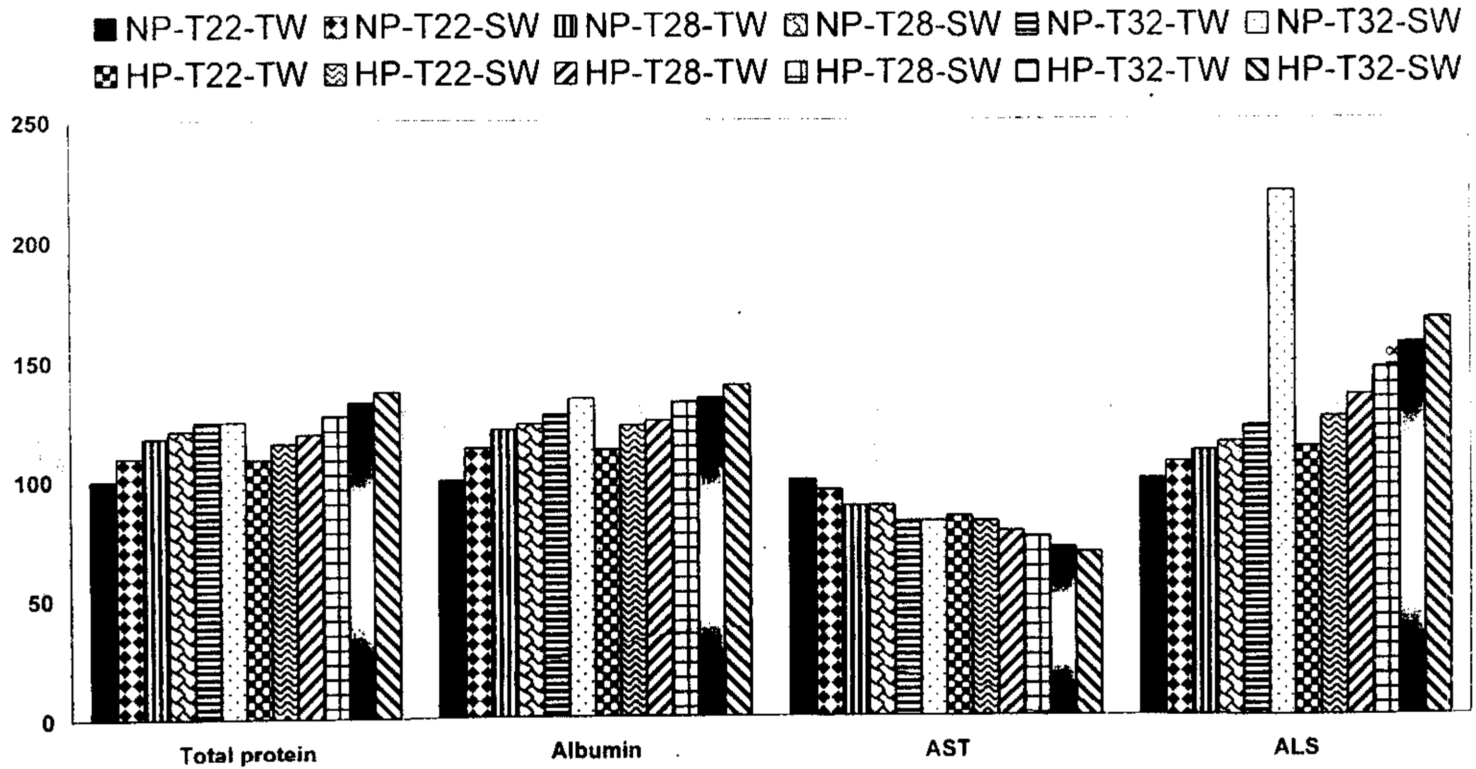


Figure 6: Chemical analysis of whole Nile tilapia fish as affected by dietary protein level, water temperature and salinity and their interaction at the end of experiment (% on dry matter basis).

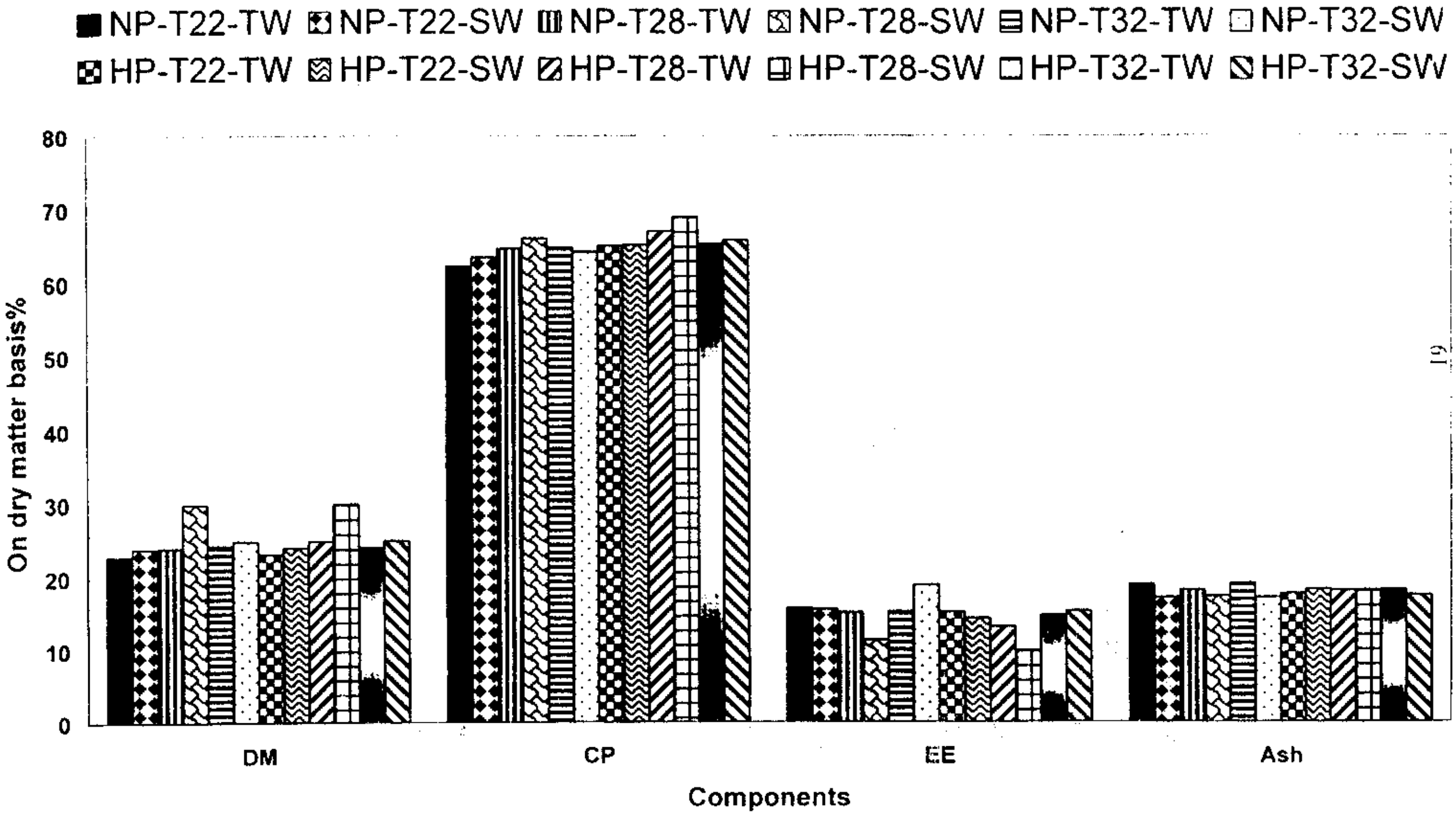


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Figure 7: Chemical analysis of flesh Nile tilapia fish as affected by dietary protein level, water temperature and salinity and their interaction at the end of experiment (% on dry matter basis).

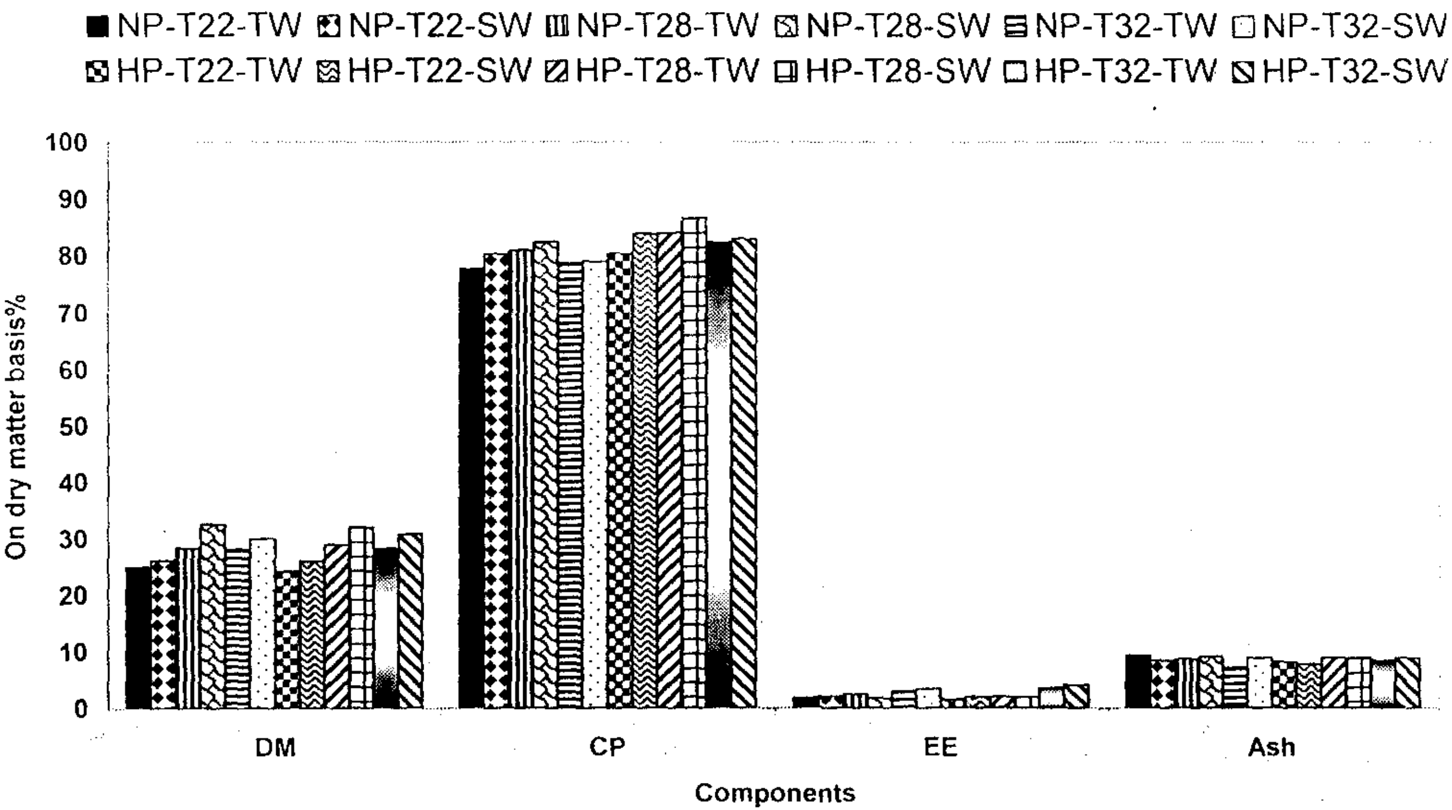
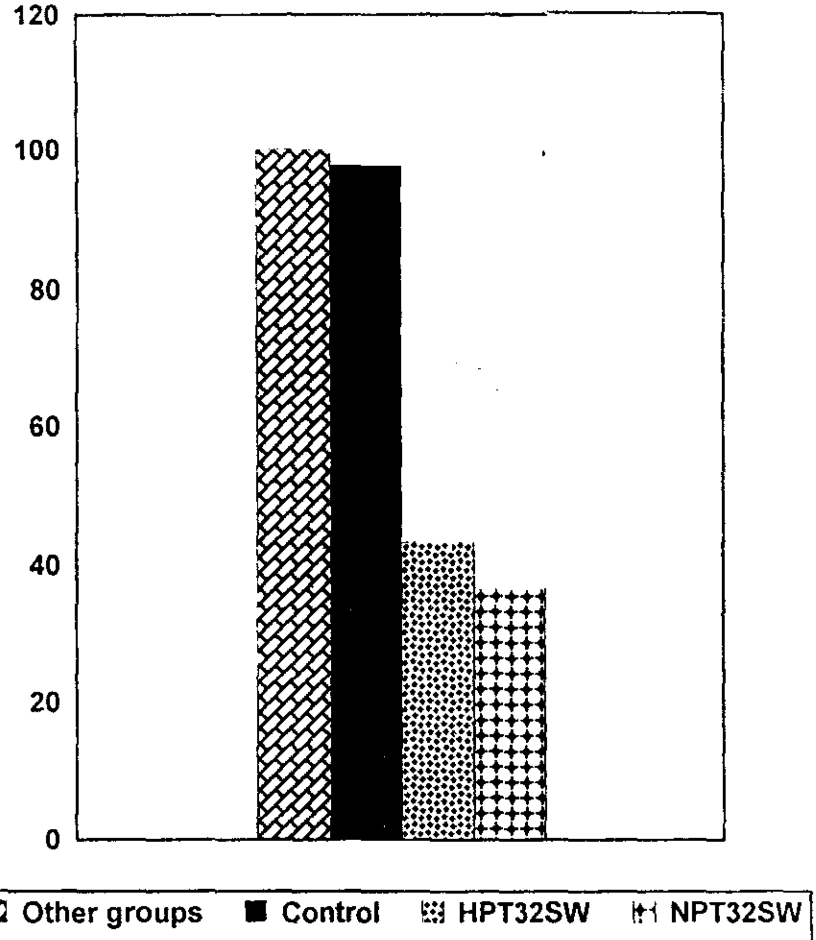


Figure 8: Survival rate (%) of Nile tilapia fish as affected by dietary protein level, water temperature and water salinity and their interaction at the end of experiment.



دراسات غذائية على بعض العوامل التى تؤثر على نمو الأسماك

جمال الدين على عبد الرحمن *، صلاح محمد عياط*، مصطفى ميرغنى عبد الحميد**، سناء جاد الكريم إدريس**

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اجرى البحث على إصبعيات أسماك البلطى النيلى بوزن ابتدائى (١٩,١–٢٢,٩٩جم) فى ٣٦حوض زجاجى بسعة ٧٥ لتر للحوض وكثافة قدرها ١٠سمكات لكل حوض لمدة ٢٠ أسبوع بعد فترة أقلمة (١٥يوم) حيث تم تغذية الإصبعيات بمعدل ٣% من الوزن الحى لمدة ٦ أيـام/أسـبوع ومعدل ٤ مرات يوميا (٨ صباحا، ١٢ظهراً ،٢، ٥ مساءا) وذلك لدراسة مـدى تأثـير كـل مـن مستوى البروتين فى العليقة (٣٠ ، ٣٥%) ودرجة حرارة المياه (٢٢، ٢٨، ٣٢°م) وكذلك ملوحة الماء (٣,٠ ، ١٥جزء فى الألف) وكذلك التداخل بين هذه العوامـل علـى كـل من معدلات النمو والاستفادة من الغذاء وكذلك مكونات الجسم ولحم الأسماك وكذلك مكونات الدم وأيضاً معدل البقاء لأسماك البلطى.

وقـد أوضـحت النتائج أن هناك زيادة معنوية ($P<0.001$) فى كل من معدل النمو والاستفادة من الغذاء بزيادة مستوى كل عامل على حدى وكذلك التداخل بينهم حيث سجلت مجموعـة الأسـماك التى تم تغذيتها على عليقة تحتوى على (٣٠ أو ٣٥%) بروتين خام ودرجـة حـرارة ٢٨°م ودرجة عالية من ملوحة الماء (١٥جزء فى الألف) أفضل معدلات الـنمو واستفادة من الغذاء هذا بالإضافة إلى تحسين مكونات الجسم مع زيادة نسبة معدل الـبقاء (٤٣,٣٣%) بيـنما انخفض هذا المعدل إلى (٣٦,٦٧%) للمجاميع التى تم تغذيتها علـى نفس مستوى من البروتين وتحت ظروف عالية من الحرارة (٣٢°م) وملوحة الماء (١٥جـزء فى الألف) بينما مجاميع الكنترول سجلت معدل بقاء ٩٦,٦٧% ، ١٠٠% لباقى المجاميع الأخرى.

لذلـك فإن مستوى البروتين (٣٠ أو ٣٥%) ومستوى درجة الحرارة (٢٨°م) تحت معـدل عـالى مـن درجة الملوحة (١٥ جزء فى الألف) تعتبر أفضل المستويات بالنسبة لمعـدلات النمو واستفادة أسماك البلطى النيلى من الغذاء وتحسين مكونات الجسم بالإضافة إلى ثبات نسبة البقاء (١٠٠%) وذلك بالمقارنة بالمجاميع الأخرى.