EFFECT OF FEEDING SYSTEMS ON PERFORMANCE OF CAGED GILTHEAD SEABREAM (*Sparus aurata*) UNDER EGYPTIAN CONDITIONS

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SUMMARY

The present study is an attempt on the way of pisciculture intensification of gilthead seabream (*Sparus aurata*) to evaluate the utilization of two different wet (sea) feeds and a dry aquafeed with caged juvenile *S. aurata*. The study was carried out during 1999 under on-farm ambient conditions in the Governmental Fish Farm at Damietta (Al-Mousallas). Each cage was stocked by 30 fingerlings. Three groups, each of three cages (replicates) were allotted to receive gradually the experimental diets. which consisted of pelleted diet (1), trash fish (2) or small shrimp (3). All diets were daily offered at a fixed feeding rate of 6% of the wet body weight of fish over a 6 days working week for twelve weeks.

The water quality criteria measured in the experimental area were suitable and within the recommended ranges of seabream aquaculture. Diet No. 3 contained higher protein percentage; yet, diet No. 1 was better than the other tested diets in essential amino acids index, egg protein ratio and biological value. Therefore, diet No. 1 reflected superior ($P \leq 0.05$) final body weight, condition factor, daily weight gain, specific growth rate, feed consumption and feed conversion efficiency compared with both wet diets (No. 2 and 3). Fish body composition at the end of the experimental period revealed that diet No. 1 gave significantly higher fat and lower crude protein percentages than the other diets. Fish group fed on pelleted diet (1) reflected significantly better nutrient utilization than that fed on diet 2 or diet 3. Diet 1 was more expensive than the live foods (2 and 3). thus the cost of one Kg fresh fish produced by feeding on diet 1 was more than five times compared with diets (2 and 3). The clinical examination revealed presence of corneal cloudiness in fish group fed on the pelleted diet. Although, there were no fungal growth in the experimented fish, their kidneys and liver were invased by *Vibrio anguillarum*. The parasite *Paramaeba* Sp. infected the gills of all fish groups. Some histopathological alterations were described in gills, muscles, liver and intestine. It is recommended to use live feeds (very cheap, similar in protein/energy ratio and biological value compared with the good quality dry feed) in the artificial feeding of cultured carnivorous fish. However, trash fish were more better than small shrimp concerning growth performance, nutrients utilization, survival rate and lower parasitic invasion.

***Keywords:* feeding systems, caged gilthead seabream (sparus aurata), Egyptian conditions**

INTRODUCTION

The gilthead seabream (*Sparus aurata*) is successfully cultivated in the Mediterranean region and representing about 48% of the total fish culture of this region (Meyers, 1997). It is one of the most important commercial fishes

(Eisawy and El-Bolock, 1975). Seabream is a carnivorous fish, mainly piscivorous and live a benthic life (Wassef, 1985). Seabream culture has traditionally relied in monoculture cages or in natural ponds food organisms and little supplementary feeds to provide most or all of their nutritional needs (Wassef and Abu El-Wafa, 1985). Formulated feed ensures constant growth, it is also more efficient when compared to trash fish, cleaner and easier to handle, although many farmers still find using trash fish more profitable (Anon., 1999). Yet, formula cost for aquatic species is typically higher than that for terrestrial species (Suresh, 2000). Therefore, if aquaculture is to sustain its continuity and development, it will have to make maximum use of locally available feed resources (El-Sayed, 1999). Thus, the aim of the present study was to evaluate some aquafeeds, mainly a pelleted diet, trash fish and small shrimp by testing growth performance, feed utilization, fish composition, economical efficiency and veterinary examinations of gilthead seabream.

MATERIALS AND METHODS

Experimental Fish:

Juvenil gilthead seabream (*Sparus aurata*) used in this study were collected from Mediterranean sea coast-Damietta (El-Tawal northern Manzalah Lake) using scoop net and traps. The fish were then transported in a plastic tank (Filled with brackish water) using a car. After their arrival, they were kept in a hap (3.5 x 2 x 1 m) and fed on trash fish for one week for the adaptation. Thereafter, 270 individuals (approximately similar in size) were selected and randomly divided into 3 groups, each of 3 replicates. Each replicate, i.e. 1 m^3 cage, was stocked by 30 fish. Average weight of the fish was 10.5 ± 0.5 gram.

Rearing Cages:

Floating net cages with wooden frams were personally designed and anchored in the Damietta Governmental Fish Farm (at Al-Mousallas) which is an earthen ponds farm supplied by highly brackish water from Ratama canal, Suffara canal and agricultural drainage. The cages were immersed in the water for 75 cm of their depth. The distance between the cages floor and the pond bottom was ca. 50 – 75 cm at least. Mechanical cleaning of the cage – net biofoulers was carried out regularly.

Experimental diets and practice:

The fish were starved for 2 days, thereafter the experimental diets were offered together with trash fish gradually to become 100% experimental diets within one week. The experimental diets consisted of:

Diet No. 1: a pelleted feed formulated from 55% imported fish meal, 35% soybean meal, 4.5% wheat milling, 3% imported cod liver oil, 1% vitamins mixture, 1% minerals mixture, and 0.5% sodi alginate as a binder. All ingredients were mixed, water at 25% of the total weight was added, the mixture was minced in a meat mincer to pass through 3 mm pores, and finally air dried. All ingredients were purchased from the local market, vitamin and mineral mixtures were purchased from PHRCO Pharmaceuticals (Alexandria), whereas fish meal and cod liver oil were imported.

Diet No. 2: It consisted of trash fish "Ton or Btahesh" *Aphanius fasciatus* as a small fish available in Al-Manzalah Lake. It was caught daily and offered fresh after trashing. Diet No. 3: It consisted of small shrimp "Delp" *Palaemon* spp. available in Al-Manzalah Lake. It was used fresh after crushing.

Criteria Measured:

Quality parameters of the surface water surrounding the cages were measured weekly and the chemical analyses for diets and fish at the beginning and at the end of the experiment were carried out according to the methods given by Abdelhamid (1996), whereas growth performance and feed utilization parameters were calculated using equations cited from Abdelhamid (2000). The amino acids profile was determined at The Central Laboratory for Foods and Feeds, Cairo. Essential amino acids index (EAAI), egg-protein ratio (EPR) and biological value (BV) as well as energy contents were calculated after Nehring (1972). The fish were clinically and parasitologically inspected and bacteriologically and mycologically examined according to Noga (1996), whereas the histopathological examination was undertaken after Lillile and Fulmen (1976). Statistical analysis of the obtained data was performed according to Harvey (1990) and Duncan (1955).

RESULTS AND DISCUSSION

1- Water quality criteria:

The average values of water quality criteria during the experimental period were 26.13°C, 23.21‰ salinity, 8.342 pH, 6.633 mg/l dissolved oxygen, 133.2 µg/l ammonia, and 270.5 mg/l alkalinity. The highest alkalinity level was associated with the highest pH value and lowest dissolved oxygen concentration at end July; since increased water temperature at end July may stimulate primary productivity leading to elevated pH value and alkalinity as well as activation of fish to consume more feed and oxygen resulting in low oxygen level at this time as cleared by Krom *et al.* (1985). However, these parameters' values are suitable for rearing gilthead seabream (Eisawy and Wassef, 1984).

2- Experimental diets:

On day matter basis, all diets were – to some extend–similar in their crude protein contents; yet, trash fish (diet 2) contained ca. 2 folds fat than the other diets and small shrimp (diet 3) contained more ash percent than diets 1 and 2 (Table 1). However, New (1986) and Abdelhamid (2000) cited that trash fish is widely used for feeding in commercial fish culture of many species, particularly seabream which are adapted to receive food of animal origin (Cataldi *et al.*, 1987), although some problems are appeared when some species of trash fish are fed raw. Anyhow, protein in gilthead seabream larval diets may reach up to 65%, whereas fingerling and grow-out diets typically containing 50 – 55% crude protein (Morris, 1998).

Table (1) illustrates also that the dry feed (diet No. 1) had higher total and essential amino acids as well as nutritional values (as EAAI, EPR and BV) than the wet diets No. 2 and 3 which were nearly similar. The obtained levels of essential amino acids in the tested diets, particularly live diets, were lower than the dietary requirements of *S. aurata* fingerlings recorded by Vergara (1992) being 1.59 – 2.96 vs. 4.35% arginine, 1.65 – 2.26 vs. 3.75% isoleucine, 2.83 – 4.49 vs. 5.25% leucine, 2.77 – 3.67 vs. 5.50% lysine, 0.33 – 1.11 vs. 2.00% methionime, 1.71 – 3.15 vs. 3.68% threonine, and 2.09 – 2.78 vs. 3.28% valine. However, the nutritional value of a diet is affected by processing, source and quality of the same dietary animal protein source (Deguara, 1997).

3- Performance of the fish:

Table (2) presents data of some performance criteria of the experimental fish. Although there were no significant

($P \geq 0.05$) differences among the experimental groups concerning initial body weight, final total body length and survival rate; yet, the pelleted diet (No. 1) reflected pronounced ($P \leq 0.05$) superiority in the final body weight, condition factor, daily body weight gain, specific growth rate, feed consumption and feed conversion efficiency compared to either or both diets (No. 2 and 3). Additionally, there were no significant ($P \geq 0.05$) differences between both diets No. 2 and 3, except for feed conversion. However, the calculated condition factor in the present study is similar to that mentioned by Abu El-Wafa (1988). Additionally, Wassef (1990) reported that growth rate in fish length is greater than in fish weight during the first year of age in gilthead seabream. This may be the reason for the lower growth rate and feed efficiency obtained herein than those reported for older gilthead seabream in other studies (Aksnes *et al.*, 1997).

The present results of diet No. 1 are in agreement with the findings of Kissil and Koven (1987) who reported the best growth, feed conversion and survival of gilthead were obtained with the diet which was similar to hen's egg in amino acid balance. Comparable growth rates (0.34 – 0.46%/day) were obtained by Wassef (1991) under aquarium conditions. However, highest specific growth rates for gilthead seabream fry were obtained in fish fed 55% protein diet at a fixed daily feeding rate of 6% of body weight (Vergara *et al.*, 1996). Additionally, high levels of dietary lipids decrease the volume of digestive liquids (Fountoulaki *et al.*, 1997). Therefore, diet No. 2 gave lower fish growth, feed efficiency and consequently lower nutrients utilization (Table 3) than diet No. 1. On the other hand, Goldan *et al.* (1998) did not find effects of food type (dry – live – high protein – low protein) on survival rate of juvenile gilthead seabream; however, the growth rate was affected.

Although *S. aurata* consumed more pelleted diet than live food in the present study; yet, Wassef and Eisawy (1985) mentioned that this fish species eat soft-bodied animals (polychaetes, crustaceans and fishes). However, Zeinhum (1998) reported that dietary animal/plant proteins mixture (as in diet No. 1 herein) have pronounced effects than animal (alone) protein source on fish weight, growth rate, feed intake and feed conversion.

4- Fish composition and nutrients utilization:

Chemical analysis data of whole fish bodies (Table 3) showed some variations of the results at the beginning compared to that at the end of the experiment as age effect. However, the main effects were reflected in significant decreases of crude protein % and increases of fat % and ash %, except diet 2 where ash content was lower than at the beginning of the experiment. In accordance with the present study, Ballestrazzi *et al.* (1994) reported that protein contents of seabass increased as the dietary protein level increase, while fat and energy contents decreased accordingly.

Haiqing and Xiqin (1994) gave a conclusion which agrees with the present results, since they found no significant effect of varying dietary energy content on body composition of seabream fingerlings.

Moreover, Vergara *et al.* (1996) reported that carcass composition of gilthead seabream fry was only slightly affected with the dietary crude protein levels (35–65%). Yet, the increase of dietary lipid produced an increase in body lipid deposition (Grigorakis *et al.*, 1997) as found in the present study (diets 1 and 2).

Table (1): Chemical evaluation of the experimental diets on dry matter basis.

Items	Experimental diets No.		
	1	2	3
Crude protein, %	54.16	52.90	61.93
Ether extract, %	10.90	25.66	12.24
Ash, %	17.90	21.44	26.16
Total amino acids, g/16 g N	90.64	72.50	71.21
Essential amino acids, g/16 g N	44.30	33.16	33.49
EAAI	0.458	0.300	0.384
EPR	47.81	31.72	37.55
BV	16.21	16.04	16.13

Table (2): Performance criteria of gilthead seabream during 12 weeks experimental period.

Items	Experimental diets No.		
	1	2	3
Initial body weight, g	10.44	10.47	10.57
Final body weight, g	25.62^{b}	19.58^{a}	18.50^{a}
Final total body length, cm	11.82	11.65	11.16
Condition factor	1.557^{b}	1.247^{a}	1.333^{ab}
Daily body weight gain, mg	181.0^{b}	108.0^{a}	95.00^{a}
Specific growth rate, %/d	0.465^{b}	0.323^{a}	0.290^{a}
Survival rate, %	89.99	98.89	80.00
Feed consumption, g	67.97^{b}	58.17^{a}	55.75^{a}
Feed conversion	4.250^{c}	6.370^{b}	7.027^{a}

a-c: Means in the same row superscripted with different letters differ significantly at $P \leq 0.05$.

Data of protein efficiency ratio (PER), protein retained (PR), protein productive value % (PPV %), fat retained (FR), fat retained % (FR%) and energy efficiency (EE) are summarized in Table (3). It is obviously that diet 1 reflected significantly better PER, PR, PPV%, FR, FR% and EE than the other diets 2 and 3, respectively. However, both diets 2 and 3 did not significantly differ between each other except in FR.

Comparable results were obtained by Catacutan and Coloso (1995) who reported better PER and PR on low protein diet (42.5%) than higher protein one (50%) for juvenile Asian seabass. However, Vergara *et al.* (1996) found that PER for gilthead seabream fry showed a trend towards an increase up to a maximum with 55% dietary protein. They added that there were no significant effects of dietary lipid levels on the PER in seabream fingerlings.

Zeinhum (1998) findings agree with the herein obtained results, since the higher protein diet resulted in lower PER and PPV%. He found also that dietary protein mixture of animal and plant sources was more better on affecting EE.

5- Feed costs:

Average feed costs were calculated on the basis of local market prices (Table 4). The pelleted diet (1) was expensive due to its contents of imported fish meal, therefore the feed cost to produce one Kg gilthead seabream fresh fissile was 565% higher than diets 2 and 3, both diets 2 and 3 were more economically.

The pelleted aquafeed is generally expensive, so Hassanen (1997 and 1998) calculated the feed cost per Kg gain as 2.43 – 4.22 or 3.33 – 6.13 L.E. for diets based on soybean meal or lupin-seed meal, respectively for *S. aurata* (3–7 g initial body weight) reared in fiber-glass tanks. However, as feed quality improves, the cultural system gradually intensifies and feeding aspects become more important from economic points of view (Coche, 1982). Anyhow, seabased (caged gilthead seabream) showed higher profitability than the land based (concert tanks) by about 8 times because of the lower investment and costs related to oxygen and electricity (Blakstad *et al.*, 1996). The local wild production of seabream graduall decreased (Abdel-Hakim *et al.*, 1997). However, intensive marine fish farming in the

6- Veterinary inspections:

Clinical signs and post-mortum changes:-

The most clinical sings of the examined fish were ptechial hemorrhages at the body surface, especially at the base of dorsal and pectoral fins and isthmus. Corneal cloudiness was observed in fish fed on pelleted diet. Few fishes showed patches of fad pigmentation at the dorsal sides of fish as shown with caudal fin rot. Internally, there were accumulations of turbid ascetic fluid in the abdominal cavity. Liver was pale yellow discolored and gills were also pale. It is surprising that although the moist feed naturally contains thiaminase leading to deficiency of vitamin B_1 in form of corneal cloudiness; yet, the same symptom appeared (in the present study) among fish group fed on pellets. This perhaps means that diet 1 was deficient in both vitamins B_1 and B_2 as causative agent for cloudiness of the eye lens (Meyer *et al.*, 1980).

Bacteriological and mycological examinations:

The results of the bacteriological culture from anterior kidney and liver revealed the presence of *Vibrio anguillarum*. The isolated bacterium has been identified after the characteristics of *Vibrio anguillarum* of Post (1983). The

Table (3): Chemical composition of the whole fish body (% dry matter basis) and the nutrients utilization of the githead seabream fed on different experimental diets for 12 weeks.

Items	At the start	At terminal of the experiment		
		Experimental diets No.		
		1	2	3
Moisture	70.98	69.14	72.90	73.49
Protein	64.14	49.04[b]	56.01[a]	58.51[a]
Fat	14.16	27.86[b]	23.88[b]	17.77[a]
Ash	21.70	23.12	20.77	23.63
Protein efficiency ratio		0.389[a]	0.296[a]	0.260[a]
Protein retained		5.897[b]	4.243[a]	4.050[a]
Protein productive value %		15.05	13.79	11.76
Fat retained		5.600[c]	3.177[b]	1.840[a]
Fat retained %		75.69[b]	21.65[a]	26.96[a]
Energy efficiency		25.66[b]	15.70[ac]	15.22[a]

a-c: Means in the same row superscripted with different letters differ significantly at $P \leq 0.05$.

Table (4): Feed cost per Kg of gilthead seabream fed on the experimental diets for 12 weeks in cage culture.

Items	Experimental diets No.		
	1	2	3
1- Cost per Kg diet, L.E.	3.20	0.50	0.50
2- Consumed feed to produce one Kg fish, Kg.	2.66	2.95	3.00
3- Feed cost/Kg fresh fissile, L.E.	8.50	1.48	1.50
4- Relative % of feed cost/Kg fish	574	100	101
5- Feed cost/Kg gain, L.E.	14.4	3.20	3.50
6- Relative % of feed cost/Kg gain	450	100	109

1- The local prices of the ingredients were: Fish meal (65% protein, Peru) 3.25 L.E/Kg, soybean meal (44% protein) 1 L.E/Kg, vitamins and minerals 4.50 L.E/100 g, fish oil 1.50 L.E/L and wheat milling 1.25 L.E/Kg.
2- Feed intake per fish per period/final weight per fish, Kg/Kg.
3- Step. 1 x Step. 2.
4- Respective figures for Step 3/lowest figure in this step.
5- Feed intake per Kg gain x Step 1.
6- Respective figures for Step 5/lowest figure in this Step.

Mediterranean area is almost totally based on the use of complete dry diet (Lanari and Tibaldi, 2000).

results of mycological culture revealed the absence of any fungal growths.

Generally, farmed fish are susceptible and carrier for various pathogens, among these are vibrio bacteria (Richards, 1984). Therefore, new measures should be considered to reduce bacterial loads as well as to selectively manipulate the microflora both in the live feeds produced in the hatchery and in the culture water prior to stocking of the fish (Sorgeloos *et al.*,1995).

The parasitological examination:

The gill smear showed *Paramoeba* sp. cysts inside the tips of gill filaments, whereas the skin smear showed no parasitic infestations. Intestinal scrape showed digenetic trematode. Regarding to the parasitological investigation of skin and gills of examined fish, it showed parasitic infestation of gills with *Paramoeba* sp. Specially, in fish fed on shrimp and to least extend in fish fed on small fish, but no infestation was recorded in fish fed on artificial diet. From the histopathological examination of intestine of fish, there was also parasitic infestation with digenetic trematode. This explain that shrimp or small fish, which used as fish food act as a second intermediate host harboring the encysted metacercaria imbedding in their muscular tissue.

Both types of parasites, either of gill or intestinal, the route of transmission is through ingestion of infested fish or crustacean (Woo, 1995). The histopathological findings associated with *Paramoebic* sp. infection, which reported by Munday *et al.* (1990) agree with the present results. Actively secreting mucus cells were numerous in the affected areas of the gills, both at the surface and deep within the hyperplastic epithelium. In contrast, chloride cells are reduced in number in the effected areas (Roubal *et al.*, 1989).

The histopathological examination:

Gills showed parasitic infestation with *Paramoeba* sp. which are intercellular parasites, with a direct life cycle. *Paramoeba* sp. Freshly removed from infected gills. It was presented in subspherical and transitional forms within the gill epithelium. In the following (Figs. 1 – 4) are the alterations described in gills, Muscles and intestine of the tested fish. The present data of all examined fish showed the typical clinical signs of vibriosis in salt water fish as previously described by Noga (1996).

The accepted explanation for the prevailing of the bacteria in the three treatments is that the bacteria are found in the gastro – intestinal tract of fish in commansal state and when the water temperature if rises causing low immune response of fish under effect of other stressors. Also it becomes more virulent and able to produce disease signs in immune compromized host. Regarding to the results of parasitological examination in the three treatments, there was a prevalence of parasitic infestation.

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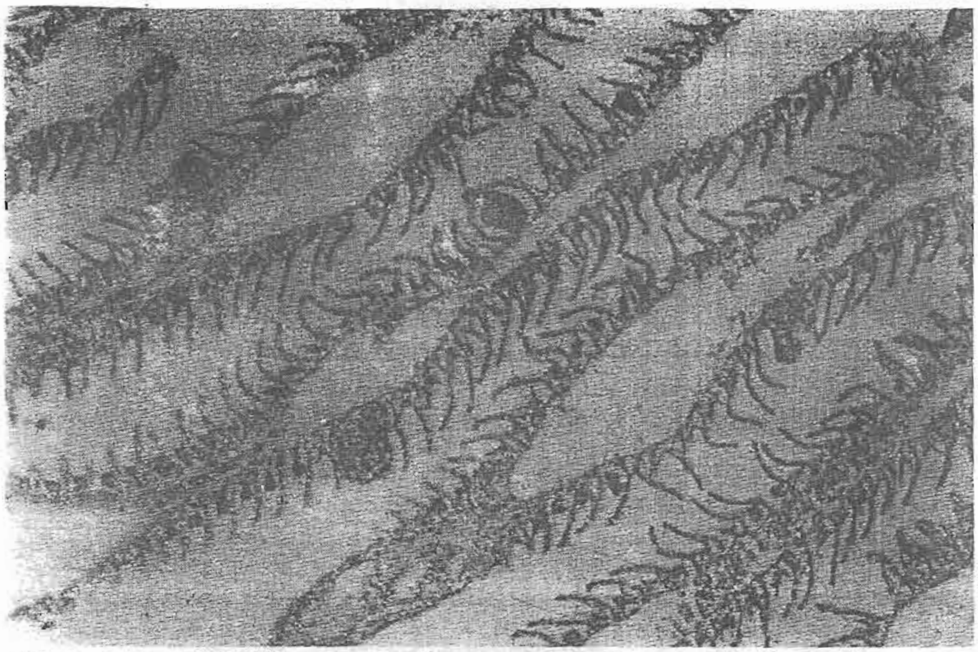

Fig. 1: Gills showing Mxyosporidium sporocyst in the secondary lamellae (H & E x 300).

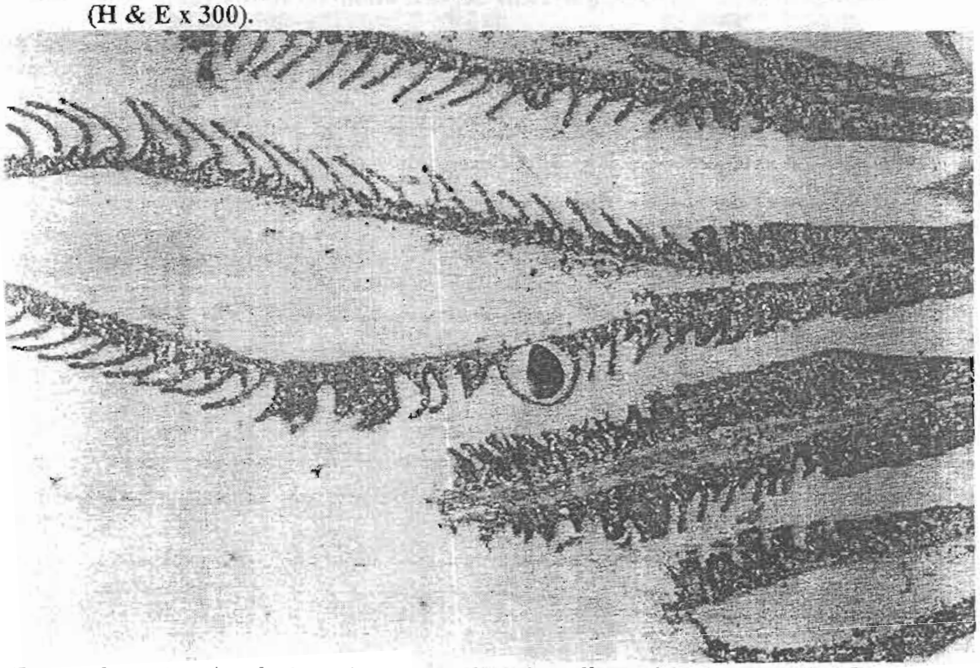

Fig. 2: Gills showing fusion of the secondary lamellae with congestion of blood vessels in addition to the parasitic element (H & E x 300).

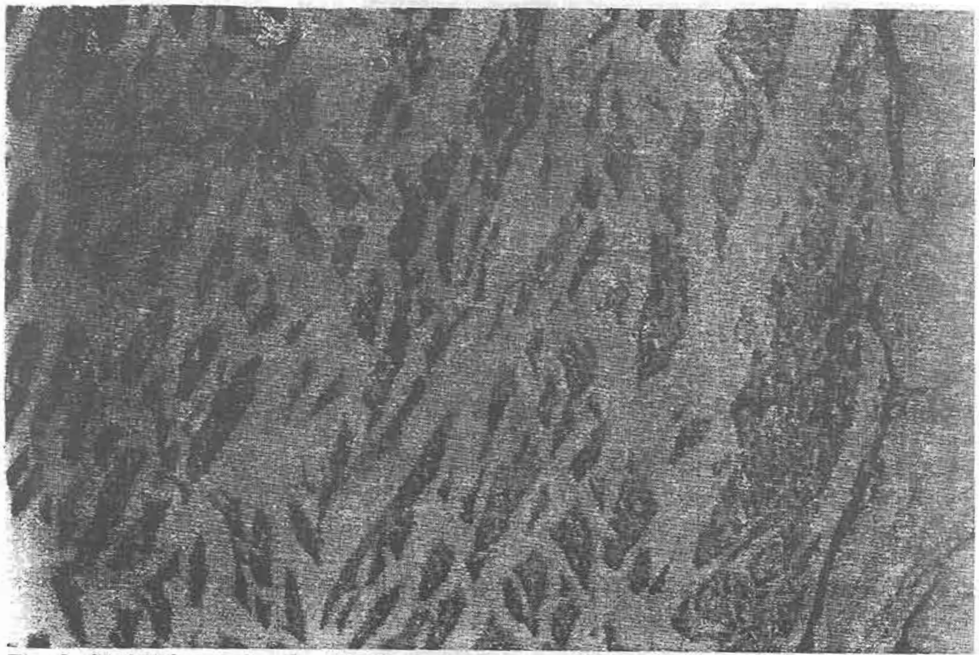

Fig. 3: Skeletal muscles showing hyaline degeneration (H & E x 120).

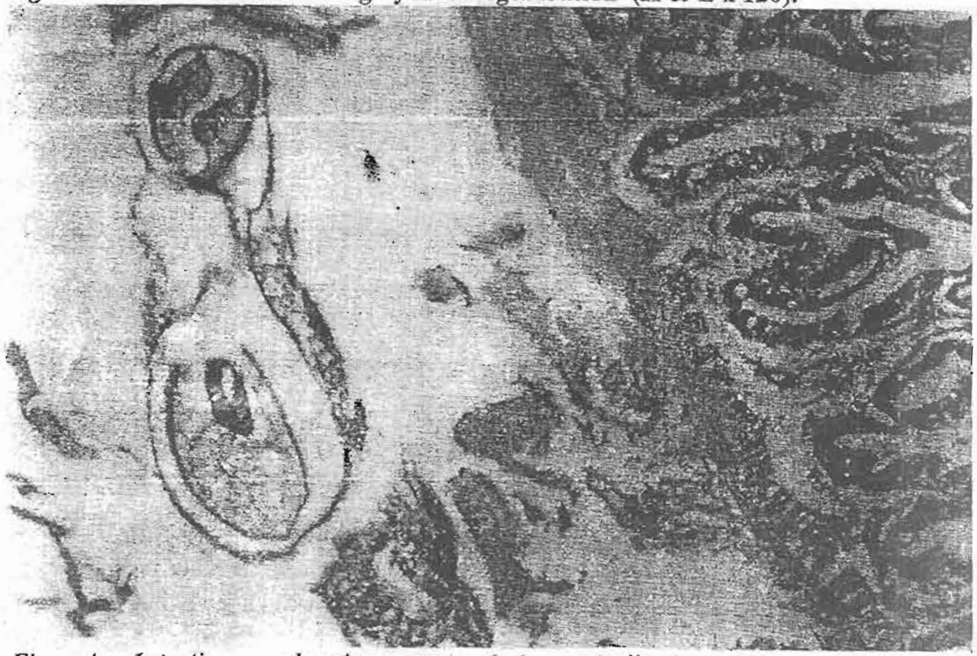

Fig. 4: Intestine showing catarrhal enteriis in addition to parasitic element (H & E x 120).

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تأثير نظام التغذية على أسماك الدنيس المربى فى أقفاص تحت الظروف المصرية٠

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الدراسة الحالية ما هى إلا محاولة على طريق الإستزراع المكثف لأسماك الدنيس لتقييم الإستفادة من نوعين من الأغذية البحرية الرطبة وكذلك الغذاء الجاف مع صغار أسماك الدنيس٠ أجريت هـذه الدراسـة عـام ١٩٩٩م تحت ظروف المزرعة الحكومية بدمياط للأسماك٠ تم تخزين ٣٠ أصبعية أسماك فى كل قفص وكونت ٣ مجاميع، كل مجموعة من ٣ أقفاص (مكررات)٠ ثم تناولت كل مجموعة من المجاميع الثلاثة العلائق الآتيـة: وهى ١- عليقة جافة، ٢- سمك صغير، ٣- جمبرى صغير٠ وكانت تقدم العلائق الثلاثة يومياً ولمـدة ٦ أيـام أسبوعياً بمعدل ٦% من وزن الجسم الرطب لمدة ١٢ أسبوعاً٠

كانت مقاييس جودة المياه فى منطقة التجربة مناسبة وداخل الحدود الموصى بـها لاسـتزراع أسـماك الدنيس٠ العليقة رقم ٣ كانت تحتوى على أعلى نسبة بروتين إلا أن العليقة رقم ١ كانت الأفضل عـن العلائـق المختبرة الأخرى فى دليل الأحماض الامينية الأساسية ونسبة بروتين البيض والقيمة الحيوية٠ فقد تميزت العليقـة رقم ١ بأفضل وزن جسم نهائى، ومعامل حالة، وزيادة وزنية يومية، ومعدل نمو نوعى، ومعدل إستهلاك للغـذاء وكـفاءة تحـويل الغـذاء عن كل من العليقة رقم ٢، ٣٠ تركيب الجسم عند نهاية التجربة أكد أن العليقة رقم ١ أعطت أعلى نسبة دهن وأقل نسبة بروتين خام مقارنة بالأسماك التى غذيت على العلائق رقم ٢، ٣٠ مجموعـة الأسماك التى غذيت على عليقة ١ (جافة ومحببة) كانت أكفأ استفادة من كل المغذيات معنوياً عـن التغذيـة علـى العليقة ٢ أو العليقة ٣٠ كانت العليقة رقم ١ أكثر تكلفة عن العلائق الرطبة (العليقة رقم ٢، ٣)، لذا كانت تكلفـة إنتاج واحد كيلو جرام سمك بالتغذية على العليقة رقم ١ أكثر خمس مرات عن التغذية على العلقتين رقمـى ٢، ٣٠ أظهر الفحص المرضى للسمك وجود عتامة على عدسة العين عند التغذية الجافة، بالرغم من عدم ظهور عـدوى فطرية لكن إنتشرت بكتريا الفيبريو فى الكلى والكبد، كما أصيبت الأسماك بطفيل باراموبا فى الخياشـيم وأيضـاً سجلت بعض التغيرات المرضية فى أنسجة الخياشيم والعضلات الهيكلية والكبد والأمعاء٠

لذا نوصى الدراسة باستخدام الغذاء الحى (لرخص ثمنه وتساوى كل من التغذية الحية والجافة فى قيمتـها الغذائية كنسب بروتين/طاقة، وكقيمة حيوية) فى التغذية الصناعية عند استزراع الأسـماك حيوانيـة التغذيـة٠ كمـا أن السمك الصغير أفضل من الجمبرى الصغير فى تغذية أسماك الدنيس مـن حيـث مقـاييس أداء النمـو، الإستفادة من المغذيات، ومعدل الحياتية وأقل إصابة للسمك بالطفيليات٠