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# EFFECT OF DIETARY REPLACEMENT OF FRESH WATER SHRIMP MEAL INSTEAD OF FISHMEAL ON GROWTH PERFORMANCE, FEED AND NUTRIENT UTILIZATION AND CARCASS COMPOSITION OF *SPARUS AURATA*

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## SUMMARY

Six dietary treatments were carried out on *Sparus aurata* fingerlings reared in floating cages, one of them negative control (without supplementary food) and the latter five supplemented with artificial diets. Five experimental diets containing different combinations of trash fish meal (TFM) and / or fresh water shrimp meal (ShM) were prepared as following (1)100% TFM, *(2)* 75% TFM plus 25% ShM, (3) 50% TFM plus 50% ShM, (4) 25% TFM plus 75% ShM and (5) 100% ShM, respectively.

Results showed that increasing TFM in *Sparus aurata* diets improved growth performance, condition factor (k), carcass composition and feed utilization of sea bream fingerlings. Decreasing TFM in the diet from 100% to 75% led to decrease SGR % from 1.93% to 1.50%. A highly significant (P<0.01) difference in SGR% was observed between the negtive control treatment and all supplemented treatments, which reflect the importance of supplementary food in sea bream culture especially in the first stage of its life. Shrimp meal seems to be a good animal protein source but its high fiber contents lowered its digestibility and dietary value. In addition, the higher fiber content in any dietary ingredient is not corresponded with carnivorous species feeding behavior and also with the anatomic structure of digestive tract.

***Keywords:** Sparus aurata, fish meal, protein source, growth performance, feed, nutrient utilization*

## INTRODUCTION

Because protein is the most expensive component in artificial fish diets, therefore information about protein requirements for different fish species is essential in formulating well-balanced and low cost artificial diets. Protein serves a threefold role in the nutrition of fish (1) to provide energy, (2) to supply amino acids, and (3) to meet the requirements for functional proteins (enzymes and hormones). Fish on the dry weight basis, contain about 60 to 93% crude protein which explain the high protein contents required in fish diets (Ensminger and Olentine, 1979). The minimum dietary protein level for optimum growth of gilthead sea bream *(S.aurata)* is determined by about 40 % CP for the 3 g fish (Sabaut and Luquet, 1973), while Pereira *et al.* (1987) found 50% CP level to be the optimum dietary protein level for fingerlings of the same size of *S.aurata*, with 14% lipid contents. On the other side Vergara *et al.* (1996a) indicated that the level of dietary protein producing maximum growth in *S.aurata* fry is 55% CP when fed at a fixed dietary feeding rate of 6% of body weight per day. This high protein requirement must be supplied mainly from animal protein sources especially, fish meal. Although fish meal and fishery by-Products will probably remains the main source of dietary protein used within warm water aqua feeds for carnivorous fish species, it is anticipated that high quality fish meal replacers such as bacterial / fungal single cell proteins and plant protein concentrates (priced just below that of high quality fish meals) will gradually gain prominence, and eventually reduce fish meal dietary inclusion levels within aqua feeds by about half to 25-30%, and this trend will be more evident in non-fish meal producing countries than in traditional high fish meal producing countries, (Tacon, 1997). Some authors have suggested that squid meal, as fish meal replacer, contain nutritional components which are essential for successful spawning in *S. aurata* brood stock, and the beneficial effect of squid is related to its high content of essential fatty acids which mainly due to the fat-insoluble fraction of the meal (Zohar *et al.*, 1995;Mourente *et al.*, 1991 and Watanabe *et al.*, 1984).

The present study was conducted to evaluate the effect of different combinations of trash fish meal (TFM) and fresh water shrimp (Palaemon) meal (ShM) on growth performance, condition factor, chemical composition and feed and nutrients utilization for *S.aurata* cultured in floating cages in sea water.

## MATERIALS AND METHODS

This study was carried out in the marine pond in the National Institute of Oceanography and Fisheries in Alexandria during the period from 4/6/1996 to 9/9/1996.

**Experimental Fish**

Fingerlings of *S.aurata* of about 6.14 g / fish in weight and 7.2 cm in length were obtained from the Marine Hatchery of Mariout Fish Farming Company, Mariout, Alexandria, and reared as a stock for 100 day till the beginning of the study in fish rearing laboratory National Institute of Oceanography and Fisheries in Alexandria. Fingerlings were stocked in floating net cages at a rate of 15 fingerling / cage for two days before start of the present study.

**Experimental Facilities**

The recent study was carried out in experimental net cages made of iron bars in cubic shape with dimensions of 75x75x75 cm. The units were painted and then covered with nets of 50 mesh size. All units were kept floating, only 60 cm of the unit was immersed in the water and the rest of the height kept up water surface. The units were placed in a large cement marine pond (20 m length x 12 m width x 2.5 m depth). Water circulation in the pond was enough to ensure suitable level of dissolved oxygen.

**Experimental diets**

Five experimental diets containing 0, 25, 50, 75, and 100 % shrimp meal protein (ShM) in replacement of fish meal protein (TFM), were formulated (Table 1). Replacement of shrimp meal protein instead of fish meal protein were performed in diets No.2, 3 and 4 were 25, 50 and 75%, respectively.

**Table 1. Formulation of the experimental diets containing fresh water shrimp meal instead of fishmeal**

| Ingredient | Diet No. 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Trash fish meal (TFM)(1) | 80 | 60 | 40 | 20 | - |
| Fresh water shrimp meal (ShM)(1) | - | 21 | 42 | 63 | 84 |
| Soybean meal(1) | 10 | 10 | 10 | 10 | 10 |
| Wheat milling by-product (2) | 5 | 4 | 3 | 2 | 1 |
| Cod liver oil(2) | 3 | 3 | 3 | 3 | 3 |
| Vitamin mix.(3) | 1 | 1 | 1 | 1 | 1 |
| Mineral mix.(3) | 1 | 1 | 1 | 1 | 1 |
| Total | 100 | 100 | 100 | 100 | 100 |

1: 100 % TFM
2: 75%TFM+25%ShM
3: 50 % TFM + 50 % ShM
4: 25 % TFM + 75 % ShM
5: 100% ShM.

(1) Prepared from catch residuals of Anfoushy fishery. (2) Commercial. (3) Pfizer Medical Company.

**Experimental treatments, duration and criteria**

The study includes 6 treatments, five groups were fed on the experimental diets and the later group was kept without supplementary feeding (negative control), which kept without artificial feeding (natural food). Diets were introduced to experimental fish twice daily (8 am. and 2p.m.) at a daily feeding level of 5% of live body weight for 6 days per week and the experiment lasted 14 weeks. After start, weight and length parameters for experimental fish were measured every two weeks.

The proximate analysis for diets and fish bodies was carried out according to AOAC (1985) methods. Data were analyzed using generalized linear model procedure (SAS, 1995). Water quality parameters in the marine basin during the experimental period were as follows: temperature ranged between 23.8 - 28.1°C, salinity ranged between 35.6 - 39.7 ppt, dissolved oxygen ranged between 5.2 - 6.4 mg/1. The experimental diets were almost isocaloric isonitrogenous.

## RESULTS AND DISCUSSION

**Chemical composition (%) of the experimental diets**

Table 2 shows chemical analysis of the experimental diets used in the present study. Crude protein and ether extract in the tested diets were approximately similar. Crude fiber, ash and protein: energy ratio were increased with increasing shrimp meal level in tested diets, while gross energy decreased.

**Table 2. Chemical analysis of the experimental diets**

| Item \ Treatment | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Dry matter % on DM basis | 92.64 | 92.20 | 91.77 | 91.34 | 90.91 |
| Crude protein (CP) | 49.74 | 49.70 | 49.67 | 49.63 | 49.59 |
| Ether extract (EE) | 6.34 | 6.24 | 6.14 | 6.04 | 5.93 |
| Crude fiber (CF) | 1.05 | 3.89 | 6.72 | 9.56 | 12.40 |
| Ash | 18.29 | 19.34 | 20.38 | 21.43 | 22.48 |
| Nitrogen free extract (NFE) | 24.58 | 20.83 | 17.09 | 13.34 | 9.60 |
| Calculated gross energy* (K cal gross energy/ 100 g DM) | 441.41 | 424.82 | 408.34 | 391.76 | 375.12 |
| Calcalated protein to Energy ratio** (mg protein / K cal. Energy) | 112.69 | 116.99 | 121.64 | 126.69 | 132.20 |

* Gross energy (GE), (K Cal /100 g diet) calculated according to NCR (1993) using the following calorific values: 5.64, 9.44 and 4.11 K cal diet of protein, fat and carbohydrate, respectively.
**protein / energy ratio = mg protein I K cal. energy. 1:100 % TFM 2 : 75% TFM + 25% ShM
3: 50 % TFM + 50 % ShM 4: 25 % TFM + 75 % ShM 5 :100% ShM.

**Growth performance**

The results in Table 3 showed that average daily gain (ADG) (mg/fish/day) was significantly different (P<0.01) among all treatments, where the first treatment (100% TFM) recorded the highest value of ADG. On the other hand, treatment 6, which reared without supplemental artificial food (negative control) recorded the lowest ADG. The results clearly showed that increasing percentage of shrimp meal instead of fish meal in *S.aurata* diets as a main dietary protein source led to a decrease in ADG (mg/fish/day).

Specific growth rate (SGR%) was calculated for all treatments and recorded the highest value in treatment supplemented with 100%TFM, while it was the lowest value in treatment supplemented with 100% ShM among all the treatments supplemented with artificial diets. However, fish reared without supplementary food (negative control group) showed the lowest SGR% values among all experimental treatments. Results of growth performance for *S. aurata* reared under the previously mentioned dietary conditions illustrated that increasing the level of TFM in fish diet led to increases in ADG and SGR%.

The present results are in accordance with those of Gomes and Kaushik's (1989) who indicated that increasing fish meal in diets of rainbow trout led to increases in SGR%. The same results were reported also by Vergara *et al.* (1996) with sea bream fry. They indicated that increasing sardine meal versus corn starch up to 55 % protein resulted in increasing SGR %. Food supply is probably the most potent factor affecting the growth of fish (Brown, 1957), while other factors, either abiotic or biotic, only indirectly affect growth because they affect feeding and metabolism, and consequently the conversion of food into body materials and useful energy. Feed intake of *S.aurata* in the present experiment significantly increased with increasing the level of TFM inclusion in the diets. In this connection Brett (1979) reported that the process of growth is influenced by many factors, such as food, water flow, temperature, salinity, light, space, crowding as well as internal factors, e.g. age and size of fish, heredity and even environmental history of fish, especially early in life. Among these factors, food consumption is probably the most potent one affecting the growth of fishes (Brown, 1957). However, only about one third of the amount of food consumed, is contributed to actual growth (Weatherley, 1972).

***Condition factor***

Results presented in Table (4) showed that treatments I and 2, which fed trash fish meal (100% TFM) and (75% TFM + 25% ShM), respectively were the highest in condition factor (k) compared to treatments 3, 4, and 5, which were fed (50% TFM + 50% ShM), (25% TFM + 75% ShM), and (100% ShM), respectively, and differences were significant (P<0.01). Treatment 6, which was kept without supplementary feeding (negative control), recorded the lowest significant (P<0.01) value of condition factor (k) which reflected the fish nutritional condition and approved the role of balanced artificial diet in feeding of fish.The results of fish well being indicated that the best body weight, length and condition factor have been realized in the group fed 100% TFM, while the lowest value was achieved in fish fed 100% ShM. The values of body weight, length and condition factor for *S.aureta* in the present study decreased regressively as the TFM in the diet decreased. These results are in agreement with those reported by FAQ (1983) publications which showed that fish meal remains an important but very expensive ingredient and its presence even in small amounts greatly improves the nutritional value of the entire diet.

**Table 3. Effect of replacing shrimp meal instead of fishmeal on growth performance of *S.aurata* fingerlings**

| Item \ Treatment | 1 | 2 | 3 | 4 | 5 | 6 | L.S.D.(P<0.01) |
|---|---|---|---|---|---|---|---|
| Wi (g/fish) | 6.21±0.02[b] | 6.18±0.02[a] | 6.13±0.07[a] | 6.11±0.06[a] | 6.07±0.10[a] | 6.04±0.03[a] | 0.288 |
| Wf (g/fish) | 41.01±0.05[a] | 27.05±0.02[b] | 21.07±0.07[c] | 17.73±0.05[d] | 16.09±0.17[a] | 10.40±0.03[f] | 0.354 |
| Gain (g/fish) | 35.80±0.06[a] | 20.87±0.00[b] | 14.94±0.00[c] | 11.62±0.02[d] | 10.02±0.10[e] | 4.36±0.00[f] | 0.189 |
| ADG (mg/fish/day) | 355.81±0.64[a] | 212.96±0.00[b] | 152.45±0.00[c] | 118.64±0.17[d] | 102.24±1.02[e] | 44.49±0.00[f] | 0.1929 |
| SGR% | 1.93±0.06[a] | 1.500±0.00[b] | 1.26±0.01[c] | 1.09±0.01[d] | 1.00±0.01[e] | 0.55±0.03[f] | 0.027 |

Means in the same raw with the same letters are not significantly different ($p<0.01$).

1: 100 % TFM
2: 75% TFM+25%ShM
3: 50% TFM+ShM
4: 25% TFM+75ShM
5: 100%ShM
6: Negative control (without supplement food).
Wi: initial weight
Wf: final weight

**Table 4. Effect of replacing shrimp meal instead of fishmeal on condition factor of S.aurata fingerlings**

| Treatment | Item | | |
|---|---|---|---|
| | W | L | K |
| 1 | 41.0073a±0.00 | 13.4367a±0.00 | 1.6904a±0.00 |
| 2 | 27.0533b±0.00 | 11.7500b±0.00 | 1.6680a±0.00 |
| 3 | 21.0707c±0.00 | 11.1400c±0.00 | 1.5242b±0.00 |
| 4 | 17.3710d±0.01 | 10.7100b±0.01 | 1.4433d±0.00 |
| 5 | 16.0850a±0.00 | 10.2533e±0.00 | 1.4920c±0.00 |
| 6 | 10.3957f±0.00 | 9.0733f±0.00 | 1.3917e±0.00 |
| L.S.D.<0.01 | 0.0070 | 0.0070 | 0.0070 |

Means in the same column with the same letters are not significantly different (p<0.01).
1: 100 % TFM 4: 25% TFM+75 ShM
2: 75% TFM+25%ShM 5: 100% ShM
3: 50% TFM+ShM 6: Negative control (without supplement food).
W: weight L: length K: condition factor

**Fish composition (%)**

Table 5 showed that there was a significant difference (P<0.01) in dry matter (DM) between initial and final fish samples in all treatments. The highest DM content was observed in treatment No.1 which supplemented with 100% TFM, while the lowest DM content was recorded in treatment 5 (supplemented with 100%ShM) and treatment 6 (negative control). Also, the differences in all chemical composition parameters of *S.aurata* bodies were significant between initial and final fish samples. It was observed that increasing the level of dietary ShM resulted in a great decrease in the percentages of DM, CP and EE, while ash content increased. The results clearly showed that energy contents of fish bodies were decreased with increasing ShM in the diets instead of TFM. Differences were significant (P<0.01) in DM between fish fed TFM and those fed on 50% ShM (or more) containing diets, and DM content decrease with increasing the level of replacing ShM instead of TFM. Values of EE % for fish fed on the experimental diets showed the highest value in the fish fed on TFM, while the lowest value was recorded in fish fed on ShM. Differences in ash% were highly verified and significant differences (P<0.01) were observed among all treatments. Energy content in *S.aurata* bodies reached its highest level in treatment No.1, however, the lowest level was obtained in treatment No. 6. Differences between treatments No.5 and No.6 were slightly significant (P<0.05) while it was highly significant (P<0.01) between treatments No.4 and No.5. Carcass composition analysis for experimental sea bream in the present study showed that increasing TFM in the diet led to increase DM%, CP%, EE% and EC, while ash content decreased. Vergara *et al.* (1996) obtained the same trend in CP%. The present results revealed that replacing TFM versus ShM affect growth performance for sea bream retrogressively.

**Feed and Nutrients utilization**

Table 6 showed the values of feed and nutrients utilization of *S.aureta* fed different combinations of TFM and ShM. The present results revealed that increasing ShM level decreased feed intake (FI), protein efficiency ratio (PER), protein productive value (PPV%), and energy utilization (EU%), while values of feed conversion ratio (FCR) increased. The best values for all feed and nutrients utilization were recorded in the first treatment which fed on diet containing 100% TFM, while the worest values were recorded in treatment No.5 which fed on diet containing on 100% ShM diet.

Results of feed and nutrients utilization in the present study indicated that as TFM increased in diet, values of feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV%) and energy utilization (EU%) became better. The present results are in agreement with the results obtained by Hassanen *et al.* (1997) in their study on sea bass where they found that the highest value for PER and the best FCR were obtained when fish received 100% trash fish. The lower response of shrimp meal as a protein source for *S.aurata* fingerlings in the present study could be explained from the comparison between its amino acid composition, chemical score and essential amino acid index as compared with fish meal (Hepher,1988). The author showed that fish meal contains higher values of the amino acids ( isoleucine, leucine, lysine, methionine, tyrosine, therionine and valine), better chemical score and essential amino acid index as compared with shrimp meal.

**Table 5. Effect of replacing shrimp meal instead of fishmeal on chemical composition of *S.aurata* fingerlings.**

| Treatment / Item | Initial | 1 | 2 | 3 | 4 | 5 | 6 | L.S.D.(p<0.01) |
|---|---|---|---|---|---|---|---|---|
| DM% | 22.78b±0.02 | 25.52a±0.01 | 25.24a±0.08 | 24.87a±0.15 | 24.53b±0.04 | 24.20b±0.04 | 23.68c±0.02 | 0.786 |
| CP% | 51.76g±0.03 | 60.47a±0.15 | 59.05b±0.09 | 58.66c±0.17 | 57.53d±0.08 | 55.60e±0.07 | 55.20f±0.19 | 0.342 |
| EE% | 22.24f±0.20 | 24.93a±0.03 | 24.57b±0.05 | 24.22c±0.13 | 23.66d±0.05 | 23.21e±0.04 | 23.12e±0.07 | 0.279 |
| ASH% | 26.00a±0.04 | 14.60g±0.04 | 14.38f±0.04 | 17.12e±0.05 | 18.82d±0.10 | 21.19c±0.03 | 21.68b±0.11 | 0.468 |
| EC /100g | 501.87g±0.06 | 576.39a±0.11 | 564.98b±0.63 | 559.48c±0.05 | 547.73d±0.07 | 532.69e±0.08 | 529.58f±0.04 | 1.45 |

Means in the same raw with the same letters are not significantly different (p<0.01).
1: 100 % TFM 4: 25% TFM+75ShM
2: 75% TFM+25%ShM 5: 100%ShM
3: 50% TFM+ShM 6: Negative control (without supplement food).
EC: Energy content calculated according to NRC (1993) using the following calorific values: 5.64 and 9.44 K cal /g fish of protein and fat, respectively.

**Table 6. Effect of replacing shrimp meal instead of fishmeal on feed and nutrients utillization of *S.aurata* fingerlings**

| Treatment / Item | 1 | 2 | 3 | 4 | 5 | L.S.D.(P<0.01) |
|---|---|---|---|---|---|---|
| FI | 74.35±0.00a | 53.67±0.00b | 44.76±0.00c | 39.95±0.00d | 37.55±0.00e | 0.027 |
| FCR | 2.13±0.01c | 2.57±0.00d | 3.01±0.00c | 3.44±0.00b | 3.75±0.03a | 0.078 |
| PER | 0.94±0.04a | 0.78±0.00b | 0.67±0.00c | 0.59±0.00d | 0.54±0.0e | 0.017 |
| PPV % | 15.15±0.03a | 12.39±0.01b | 10.59±0.04c | 8.98±0.00d | 7.78±0.12e | 0.12 |
| EU % | 16.25±0.02a | 13.82±0.00b | 12.22±0.04 | 10.76±0.01 | 9.80±0.07e | 0.172 |

Means in the same raw with the same letters are not significantly different (P<0.01).
1: 100 % TFM 4: 25% TFM+75ShM
2: 75% TFM+25%ShM 5: 100%ShM
3: 50% TFM+ShM 6: Negative control (without supplement food).

Despite fish meal replacers usually have high crude protein content, they are usually deficient in one or more essential amino acids. (NRC, 1993; Tacon and Jackson, 1985), which lead to reduce the utilization of other amino acids included in the diet and, in that case, the fish will use these amino acids as a source of energy and excrete ammonia as an end product. These imbalances in the previous essential amino acids can be overcome to a large extent by mixing complementary protein by-product meals so as to obtain the desired essential amino acid profile (Davis *et al.*, 1989).

In spite of the majority of the studies on fish meal replacers have been evaluated from the biological or nutritional point of view, little or no attention has been given to economic analysis within these studies, and since aquaculture is usually operated as an economic activity, it follows therefore that studies concerning the development of feeds and feeding regimes be also analyzed from an economic point of view (El-Sayed and Tacon, 1997). Although certain fish meal replacers resulted in a reduced biological performance, cost-benefit analysis including incidence cost and profit indices indicated that many of the fish meal replacers tested were more economical.

In the present study, it was observed that fish growth was significantly ($P<0.01$) reduced at 25 % substitution level of shrimp meal versus fishmeal in the experimental diets. This reduction in fish growth and feed efficiency may have been related to the increased fiber content in shrimp meal, where increasing fiber content in fish feeds led to increase gastric evacuation rate which consequently led to decrease digestibility coefficient of dietary nutrients as indicated in Kirchgessner *et al.* (1986). Shrimp meal, is not (as a whole body with the chitinous membrane) a suitable source of animal protein for feeding *S.aurata* in spite of its preferability in feeding fish in nature.This could be explained according to the following reasons: 1 -lower content of essential amino acids, chemical score and essential amino acid index, 2-lower digestibility coefficient of crude protein and ether extract, 3-lower digestible energy content, and 4-higher contents of crude fiber %.

Kirchgessner *et al.* (1986) indicated that there was a negative correlation between protein digestibility coefficient and crude fiber content in the tested animal protein sources. This negative correlation between ADC% of protein and CF content was explained by Hanley (1987) who suggested that the absorption of water by the fiber component of diets containing high levels of fiber resulted in a reduction in gut transit time and a consequent reduction of protein and energy digestibility. Increasing fat content in feed increased the digestion of total energy by rainbow trout, this increase in DE could be attributed to an increase in protein digestion, carbohydrate digestion and the lipids, themselves, digestion (Watanabe *et al.*,1979).

## REFERENCES


AOAC., 1985. Association of Analytical Chemists. Official Methods of Analysis, 14th edition Washington.

Brett, J.R., 1979. Environmental factors and growth In: W.S.floar, D.J.Randall and J.R.Brett (Editors), Fish Physiology, Vol.8. Academic Press, New York, San Francisco, London, 756 pp

Brown, M.E. 1957. Experimental studies on growth. In M.E. Brown (Ed.), The Physiology of Fishes, vol.,1, Metabolism7 pp 361-400.

Davies, S.J., Thomas, N. and Bateson, R.L., 1989. The nutritional value of a processed soya protein concentrate in diets for tilapia fry) Oreochromis mossembicus, Peters). Bamidgeh, 41 (1): 3- 11.

El-Sayed,A-F.M. and Tacon,A.G.J., 1997. Fish meal replacers for tilapia: A review. Cahiers Options Mediterraneans, Vol.22, pp. 205-224.

Ensminger,M.E. and Olentine,C.G., 1979. Nutrient requirements of warm water fishes and shell fishes (revised ed.). National Academy Press. Washington, D.C. pp.13-16.

FAO (1,983). Fish feeds and feeding in developing countnes. Agriculture Development and coordination programme ADCP / REP. 83/18 Rome.

Gomes,E.F. and Kaushik,S.J.,1989. Nutritive value of lupin seed meal *(L.engystifollils)* in rainbow trout diets Nati Cong Aquaculture, Potugal. Algarve, 18-20 Jan. (1989).

Hanley, F.,1987. The digestibility of foodstuffs and the effects of feeding selectivity on digestibility determinations in tilapia (Oreochromis niloticus L.) Aquaculture, 66 (2): 163-179.

Hassanen,G.D., Ashour,A.M., Abd El-Rahman,H., Abd El-Rahman, S.H. and EL-Hammady, A.K, 1997. Effect of dietary composition on some nutritional and hematological aspects in sea bass (D.labrax). The first Scientific Conference Of the Egyptian Society for the Development of Fisheries Resources and Human health El-Arish. Oct.21 -23 (1997).

Hepher,B., 1988.Nutrition of pond fishes: Requirement for protein. Cambridge University Press Cambridge, New York pp. 175-208.

Kirchgessner, M.;Kurzinger, H. and Schwarz, F.J., 1986. Digestibility of crude imtrients in different feeds and estimation of their energy content for carp (Cyprinus carpio L.).Aquaculture, 58: 185-194.

Mourente,G.; Rodriguez, K, Tocher, D.R. and Sargent, J.R., 1991. Effects of dietary docosahexaenoic acid (DHA; 22:6 n-3) on lipid and fatty acid compositions and growth in gilthead sea bream *(Saurete L.)* larvae during first feeding. Aquaculture, 112, 79- 98.

NRC, 1993. National Research Council. Nutrient Committee on Animal Nutrition, Board on Agriculture. National Research Council, National Academy Press. Washington DC.USA, 114p.

Pereira,T. G .; Ramos,A. and Carvalho,M.M., 1987. Food conversion and growth of *Sparus aureta* under artificial diets. Pubi. Avuis. Fast. Nae. Invest. Peseas (porto), 12:127-138.

Sabaut, J. and Luquet, P., 1973. Nutritional requirements of the gilthead sea bream *(Chrysophrys aurate).* Quantitative protein requirements. Marine Biology, 18: 50-54.

SAS., 1995. Statistical Analysis Systems Institute, User guide: Statistics. Version 5 edition SAS Institute Inc., Gary, NC.

Tacon, A., 1997. Feeding tomorrow's fish : Keys for sustainability. Cahiers Options me diterrane-ennes, Vol. 22 .p.11.

Tacon, A.G.J. and Jackson, A.J., 1985. Utilization of conventional and unconyentional protein sources in practical fish feeds In Nutrition and Feeding in Fish, Cowey, C.B., Mackie, A.M. and Bell, J.G., (eds). Academic Press, London, pp.119-145.

Vergara,J.; Fernandez-Palacios, H.; Robaina, L.; Jauncy, K.; Higuera, M.and Izquierdo, M.,1996. The effects of varying dietary protein level on the growth, feed efficiency, protein utilization and body composit ion of gilthead sea bream fry Fisheries Science, 62 (4) 620-623.

Watanabe,T.; Takeuchi,T. and Ogino,C., 1979. In: Proc. of the World Symp. of Finfish Nutrition and Fish feed Technology (Ed By J.E.Halver and K.Tiews), Hamburg, pp.113-125.

Watanabe,T.; Arakawa,T.; Kitajima,C. and Fujita, S., 1984. Effect of nutritional quality of brood stock diets on reproduction of red sea bream. Bull. Jap Soc,Sci. Fish 50, 4905-501

Weatherley, A.H. 1972. Growth processes in fish. In: A.H.Weatherley (Editor), Growth and Ecology of fish populations. Academic Press; London, New York, pp.73-128.

Zohar,Y; Harel,M.; Hassin, S. and Tandler, 1995. Gilthead sea bream (Sparus aurata). In: N.Bromage and R.Roberts (Eds.). Brood Stock Management and Egg and larval Quality Blackwell Science, London, pp. 94-117.