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EFFECT OF WATER SALINITY ON GROWTH PERFORMANCE, FEED AND NUTRIENTS UTILIZATION AND CHEMICAL COMPOSITION OF GILTHEAD SEA BREAN *(SPARUS AURATA)*

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SUMMARY

The present study was conducted to investigate the effect of water salinity on growth performance, condition factor (k), carcass composition and feed & nutrient utilization of S. *aurata* fry. Experimental sea bream fry were reared under five salinity concentrations, these are Freshwater (0.45 ppt), 25 % salinity (9.75 ppt), 50 % salinity (19.5 ppt), 75% salinity (29.25 ppt) and 100% salinity (39 ppt), each treatment was triplicated. Artificial diet was introduced twice daily for all treatments at a daily feeding rate of 8 % of body weight.

The results revealed that growth performance was affected with water salinity concentration. ADG and SGR% increased with decreasing values of water salinity concentrations up to 0.45 ppt. The results revealed also that condition factor decreased with increasing water salinity, which indicate that decreasing water salinity concentration lead up to proportional increases in (k). Changing values of water salinity also affected carcass composition of the fry where DM%, CP%, EE% and EC were increased with decreasing water salinity concentrations while ash decreased. Decreasing water salinity improved feed and nutrient utilization, where FI, PER, PPV% and EU% increased and FCR decreased. In conclusion, decreasing water salinity concentrations improved the well being of *Sparus aurata* fry.

Keywords: Growth performance, feed utillzation, sparus aurata, salinity

INTRODUCTION

The sparid gilthead sea bream (Egyptian name 'Denis') *Sparus aurata,* is one of the most important fish species in mariculture programs in many countries of Mediterranean and Atlantic. The development in culture of sea bream, showed that major progress has been made over the last decade.

The future of the industry appears promising but major problems still restrict its smooth growth. Sea bream farming depends mainly on the abundance of the fry with a corresponding numbers and quality. Sea bream fry production in Egypt still not progressed either for the lack of marine hatcheries or the high mortality rates of the naturally or artificially produced fry, due to the vast gab between science and application in that branch.

Physiological conditions (growth, reproduction and other physiological activities) of fish depends mainly on genetical, environmental and nutritional factors (Nikolsky, 1962). Salinity is epigenetic abiotic determinant environmental parameter considered as one of the most causative agents of osteological, shape, and pigmentation defects in fish (Divanach *et al.*,1996). The majority of fishes are adapted to living in solutions of more or less definite osmotic pressure, and when transferred to water of different osmotic pressure they die fairly rapidly. Holliday (1969) reported that there are some beneficial effects of isosmotic salinities to teleost larvae, these beneficial effects include enhanced swimming ability, reduced metabolic activity, and increased growth rate.

Interaction between environmental (salinity) and nutritional factors indeed affects fish growth performance, chemical composition and feed & nutrients utilization. Cataudella *et al.* (1995) indicated that in the brackish water ponds of the Northern Atlantic Valli, during the first summer growing period (April-November), *S.aurata* can increase 5 times their length and 150 their weight, reaching 19 cm and over 100 g. Other previous studies showed that sea bass (Chervinski,1975) were able to grow in fresh water. Grey mullet are also successfully grown in a range of salinities (Mabrouk,1991). The aim of the present experiment was to study the effect of different water salinities on growth performance and feed and nutrients utilization of *S. aurata* fry.

MATERIALS AND METHODS

This study was carried out during July,1995 in fish rearing laboratory, National institute of Oceanography and Fisheries, Alexandria.

Water salinity

Five different concentrations of water salinities (0.45, 9.75,19.5, 29.25 and 39 ppt) were prepared by mixing 0,25, 50, 75 and 100% sea water with 100, 75, 50, 25 and 0% of previously aerated fresh water, respectively. Water salinities were measured using refractometer after the addition of fresh water to seawater in which the salinity was previousiy calculated.

Experimental facilities

Fifteen experimental glass aquaria, 6mm thickness, 100 cm in length, 40 cm in width and 30 cm in height, were used in the present experiment. Water volume in each aquarium was adjusted at 100 liter of water of different salinities as above indicated. Water was filtered and aerated using Chinese air pumps to keep the maximum saturation level of dissolved oxygen.

Experimental Fish

Gilthead sea bream (S. *aurata)* fry used in the present study were obtained from induced spawnin at the Marine Fish Hatchery, Mariout Fish Farming Company, Mariout, Alexandria. The fry ranged between 0.7 to 0.9 g in weight and 2.9 to 3.1 cm total length. It was distributed in equal numbers (25 fry per aquarium) and fish used in each treatment were approximately of similar size Triplicate aquarias were used for each treatment.

Experimental Diet

Fish in all treatments were fed on the same experimental diet which was prepared in fish nutrition laboratory, Faculty of Agriculture, Alexandria University. Fresh fish and shrimp were collected from catch residuals of the Anfoushy fishery in Alexandria, dried at low temperature (70 to 80 ^{o}c) in the laboratory, grinded and screened to fine particles. Experimental diet was prepared by mixing dried (at 70 to 80 ^{o}c) ingredients including fish meal, shrimp meal, soy bean meal, wheat milling by-product and then cod liver oil, vitamin mixture and mineral premix were added as indicated in Table 1. Water was added at 25% and the diet was homiogenized,, minced in meat mincer and dried in electrical dryer at low temperature (70 to 80 ^{o}c). Fish were fed at a daily feeding rate of 8% of its live body weight, twice daily (8 a.m. and 4 p.m.) for 6 days every week.

Table 1. Composition of the experimental diet

Ingredient	% on DM basis
Fish meal[1]	40
Shrimp meal[1]	42
Soybean meal[2]	10
Wheat milling by-product[2]	3
Cod liver oil[2]	3
Vitamin mix.[3]	1
Mineral mix.[3]	1
Total	100

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

Water Exchange

Water in each aquaria was exchanged daily in the morning before feeding , half of the water volume was replaced in each treatment by overnight stocked, aerated water. Concerning the maintenance of the same salinity in each treatment using saline water from the eastern harbor in Alexandria. Water exchange was carried out without disturbance for the experimental fry and avoiding turbidity.

Experimental duration and criteria:

This study was continued for 12 weeks. Total weight, total length were measured every two weeks. Carcass composition analysis (CP%, EE%, and ash%) for initial and final samples was carried out at the end of the experiment. Approximate analysis of diets and fish bodies was carried out according to AOAC (1985) methods. Data were statistically evaluated using generalized linear model procedure (SAS, 1995).

RESULTS AND DISCUSSION

The present study was carried out to investigate the effect of water salinity on growth performance condition factor (k), carcass composition and feed and nutrients utilization of *S.aurata* fry reared under different water salinity conditions. In view of the ongoing efforts of gilthead sea bream farming, the knowledge of its salinity tolerance range is of practical importance.

Salinity is probably the most unregulated and uncontrolled major parameter which influence the incubation and rearing marine species. The majority of workers concluded that natural high saline waters (32 -35 ppt) were optimal, while Holliday (1969) and Chervinski (1979,1984) concluded that survival of embryos and larvae of many marine fish species could be increased at low salinity. In addition, Houde (1972) found that many fish species had high survival rates over a wide range of salinity. The author did not considered salinity as critical factor as some other rearing condition factors which affect growth and survival of fish.

Growth performance:

The results of the present study (Table 2) indicated that average values of daily gain (mg/fish/day) and also the specific growth rate (SGR %) of *Sparus aurata* fry were decreased with increasing water salinity. Significant differences ($P<0.05$) were observed between groups 3 and 4. However, no significant differences were observed in SGR % between treatments 4 and 5 The highest value of SGR% was obtained in treatment No.1, where the fry reared under fresh water circumstances, while the lowest SGR% was obtained in treatment 5 where the fry reared under saline water circumstances, differences between both treatments were highly significant ($P<0.01$).

Table 2. Growth performance of *S.aurata* fry reared under different water salinities

Item \ Treatment	1	2	3	4	5
Initial weight (g/fish)	0.78±0.02^{b}	0.85±0.03^{a}	0.78±0.01^{b}	0.77±0.02^{b}	0.75±0.02^{b}
Final weight (g/fish)	6.77±0.02^{a}	6.15±0.03^{b}	5.39±0.01^{c}	4.12±0.01^{d}	3.95±0.01^{e}
Gain (g/fish)	6.00±0.00^{a}	5.30±0.00^{b}	4.60±0.00^{c}	3.35±0.02^{d}	3.20±0.00^{e}
ADG (mg/day/fish)$^{(1)}$	71.39±0.04^{a}	63.1±0.00^{b}	54.80±0.04^{c}	39.88±0.18^{d}	38.18±0.00^{e}
SGR%$^{(2)}$	2.58±0.02^{a}	2.63±0.03^{b}	2.29±0.01^{b}	2.00±0.03^{c}	1.98±0.00^{e}

Means with the same letters are not significantly different ($P<0.05$).
Treatments 1, 2, 3, 4 & 5 containing 0, 25, 50, 75 & 100% sea water, respectively.
(1):ADG= Average daily gain
(2): SGR% = specific growth rate

The present results showed that rearing of *S. aurata* fry in fresh water significantly ($P<0.05$) increased its growth performance as compared with saline water (25,50,75 and 100% of 39 ppt saline water). Previous experiments on growth of gilthead sea bream fry and juveniles were performed in sea water (Alessio, 1974 and Barnabe, 1976) and brackish water (Chervinski, 1984). Many experimental studies have shown that food intake and conversion efficiency strongly depend on environmental factors, such as temperature, salinity, food, water flow, as well as internal factors, e.g. age and size of the fish, heredity and even the environmental history of the fish, especially early in life (Bret, I 979).

The resutts of growth performance in the present study illustrate that the highest values were obtained for sea bream fry reared in fresh water, while the lowest values obtained in saline water. A similar results were obtained by Johnson and Katavic (1986) with sea bass larvae. The authors noted that growth of larvae were increased when salinity (38 ppt) was reduced to (10 ppt).

Condition factor

Results in Table 3 showed that there were significant (P<0.01) differences in weight (W), length (L) and condition factor (k) (at the end of the experiment) between all treatments reared under different water salinity concentrations with some exceptions in length (treatments 4 & 5) and condition factor (treatments 2 & 3). These results indicate that increasing water salinity may lead to proportional decrease in weight, length and condition factor. Sea bream fry reared under fresh water circumstances obtained the highest (k) values as compared with fry reared in saline water (39 ppt). In addition, fry appetite was better in fresh water than other treatments. These results are in accordance with those of McKay and Gjerde (1985), who found that growth of rainbow trout was decreased as salinity increased, they also concluded that fish appetite was significantly better at 0 ppt than at 10, 20 or 32 ppt.

Table 3. Condition factor of *S. aurata* fry reared under different water salinities

Treatment	Salinity (ppt)	W(g)	L (cm)	k
1	0.045	6.7733^{a} ±0.036	6.8000^{a} ±0.14	2.155^{a} ±0.20
2	9.75	6.4200^{b} ± 0.037	6.672^{b} ±0.02	2.070^{b} ±0.83
3	19.50	5.3867^{c} ±0.035	6.3895^{c} ±0.05	2.065^{b} ±0.07
4	29.25	4.1200^{d} ±0.029	5.9158^{d} ±0.04	1.990^{c} ±0.03
5	39.00	3.9767^{e} ±0.030	5.9110^{d} 0.04	1.911^{d} ±0.06

Means in the same column with the same letters are not significantly different (P<0.01).
Treatments 1, 2, 3, 4 & 5 containing 0, 25, 50, 75 & 100 % sea water, respectively.
W: weight (g), L: length (cm), k: condition factor = W/L^3 x100 (Beckman, 1948).

Chemical composition

Table 4 presents the chemical composition of whole body of *S.aurata* reared under different salinities (fresh, 25%, 50%, 75%, and 100%) of seawater. It was observed that increasing water salinity level led to decrease the body contents of dry matter, crude protein, ether extract, and energy, while ash content increased. Differences between initial and final results of fish body composition were significant (P<0.05). The difference was highly significant (P<0.01) between groups 1 & 5 in DM content while it was slight differences between groups 1 & 2 and 3 & 4. Crude protein, DM, EE, and EC recorded the highest values in fish reared in fresh wafer, while the lowest values were recorded in the fish reared in saline water. These results indicate in general that all chemical composition parameters (except ash) in the experimental fish decreased with increasing water salinity at the end of the experiment. This unexpected result goes to show that the energy needed for osmoregulation is over estimated and could be interpreted as a consequence of the euyhalinity of sea bass and gilthead sea bream. (Guillaume, 1986).

Table 4. Chemical composition of *S.aurata* fry whole body reared under different water salinities

Item \ Treatment	Initial	Final 1	2	3	4	5
DM %	22.59^{d}±0.26	24.83^{a}±0.26	24.40^{ab}±0.26	24.04^{b}±0.22	23.87^{bc}±0.24	23.37^{c}±0.22
CP %	51.49^{f}±0.20	55.49^{a}±0.21	55.23^{b}±0.16	54.86^{c}±0.21	54.59^{d}±0.21	53.89^{e}±0.24
EE %	21.69^{a}±0.13	24.28^{a}±0.21	24.22^{ab}±0.24	24.16^{b}±0.20	24.05^{c}±0.18	23.76^{d}±0.22
Ash %	26.82^{a}±0.22	20.23^{f}±0.16	20.55^{e}±0.22	20.98^{d}±0.24	21.36^{c}±0.22	22.35^{b}±0.20
EC %	495.16^{f}±0.22	542.17^{a}±0.21	540.13_{b}±0.23	537.48^{c}±0.25	534.92^{d}±0.26	528.23^{e}±0.27

Means in the same raw and with the same letters are not significantly different (P<O.01). Treatments 1, 2, 3, 4 & 5 containing 0, 25, 50, 75 & 100% sea water, respectively.
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 5. Feed and nutrients utilization of *Sparus aurata* fry reared under different water salinities

Item \ Treatment	1	2	3	4	5
Feed intake (F1) (g/fish)	15.29^{a} ±0.00	14.31^{b} ±0.00	12.75^{c} ±0.00	9.87^{d} ±0.00	9.71^{d} ±0.00
Feed conversion ratio (FCR)	2.55^{e} ±0.00	2.70^{b} ±0.00	2.77^{b}±0.00	3.08^{a} ±0.00	3.03^{a} ±0.00
Protein efficiency ratio (PER)	0.79^{a} ±0.00	0.75^{b} ±0.00	0.73^{c} ±0.00	0.69^{d} ±0.01	0.66^{e}±0.00
Protein productive value (PPV%)	11.13^{a} ±0.00	10.33^{b} ±0.02	9.78^{c} ±0.03	9.20^{d} ±0.11	8.58^{e}±0.02
Energy utilization (EU%)	13.21^{a} ±0.02	12.31^{b} ±0.15	11.60^{b} ±0.03	10.91^{c} ±0.02	10.17^{e}±0.02

Means in the same raw with the same letters are not significantly different (P<0.01).
Treatments 1, 2, 3, 4 & 5 containing 0, 25, 50, 75 & 100% sea-water, respectively.
FCR =Feed intake/weight gain PER = Weight gain/ protein intake PPV%= Protein gain x 1oo/protein intake
EU%= Energy gain x l00/energy intake

From the practical point of view, it seems possible for the aquaculturists to obtain an optimum growth and conversion efficiency of *S.aurata* by changing from one osmotic medium to another at the appropriate time of the year according to variation in the ambient temperature between different seasons.

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