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FACTORS AFFECTING SWIM-BLADDER INFLATION, SURVIVAL, AND GROWTH PERFORMANCE OF GILTHEAD SEABREAM SPARUS AURATA LARVAE: 2-WATER SALINITY.

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ABSTRACT

The effect of different concentrations of water salinity (15, 25, and 35 ppt salinity levels) on swim bladder (S.B.) inflation %, survival rate, and growth performance of gilthead sea bream Sparus aurata larvae were tested. Fish, two day old, were stocked at a density of 88.0 ± 2 larval /liter in fiberglass tanks (each 1 m^3 water volume). Fish larval were fed with rotifers Brachionus plicatilis at a concentration of 16 pcs /ml. Each tank was supplied with continuous aeration, constant temperature (18 ^{0}C) and 12 hrs lights daily. Water quality criteria were within the optimum limits required for rearing fish larval. The results showed that the values of swim-bladder inflation % were significantly ($P \leq 0.05$) increased with decreasing water salinity from 35 ppt to 15 ppt salinity levels. Values of larval survival rate were 47.0, 52.9, and 61.15 % for 35, 25, and 15 ppt salinity levels, respectively. Larval growths in length were significantly ($P \leq 0.05$) increased with decreasing water salinity from 35 ppt to 15 ppt salinity levels. Values of specific growth rate (SGR %) at the end of the experiment were 4.2, 4.4, and 4.8 % for 35, 25, and 15 ppt salinity levels, respectively.

It could be concluded that decreasing water salinity has many advantages in increasing swim-bladder inflation %, survival rate, and growth performances of gilthead sea bream larval.

INTRODUCTION

There are many factors affecting the formation of functional swim- bladder in fishes. These factors are the larval rearing system, stress and/or feeding conditions (quality and quantity). Non inflation and hyper inflation of swim-bladder in marine fishes, e.g. Gilthead sea bream *Sparus aurata* is a great problem affecting directly larval fish growth (Goolish and Okutake, 1999; Crespo *et al*., 2001), the percentage of fish survival rate (Florbela *et al.,* 1996; Crespo *et al.*, 2001), causes deformities in the vertebrate (Lordosis or malformations) (Andrades *et al.*, 1996; Kihara *et al*., 2002; Gavaia *et al*., 2002) and retarding the success rate in marine hatcheries and so on the production process all over the world (Al-Abdul- Elah and Ross,1993). Water salinity in larval rearing system is one of the most important factors affecting swim-bladder inflation, fish survival and growth of sea bream larval (Cornacchia, 1982; Chapman *et al.,* 1988; Al-Abdul- Elah, 1990; and Barnabe, 1990). Therefore, the objective of the present study was to study the effect of various water salinity on the effect inflation, survival, growth performance and malformations percentage of sea bream larval (2 days old).

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MATERIALS AND METHODS

Experimental Facilities:

The present study was conducted in the Commercial Marine Hatchery, km 21-west Alexandria city. Six $1m^3$ white circular fiberglass tanks were used to perform this experiment. The experimental tanks were placed in a black greenhouse supplied with artificial light (fluorescent and non-fluorescent lamps). Each tank was provided with 2 air stones.

Newly hatched gilthead sea bream *Sparus aurata* larvae were stocked in larval rearing tanks, each $1m^3$ of water volumes, at a density of 88±2 larval/l. These larval were produced in the hatchery from matured brood stocks without hormonal injection. Fertility rate was higher than 90 % and hatching rate was around 75%.

The initial water salinity for rearing the experimental larval was 35 ppt. The tested water salinities were 15, 25 and 35 ppt. To reach the low salinities (15 and 25 ppt), the newly hatched fish larval (one day old) were subjected to gradual decrease in water salinity during 1 and 2 days after hatching. Daily water exchange rate was 20, 40 and 60% during weeks 1, 2, and 3, respectively. Light intensity at the water surface was 80, 160 and 200 lux using fluorescent and non-fluorescent light during the first, second and third week, respectively. A device of oil trap was used to get rid of the oil films formed on the water surface in each tank daily.

The larval were fed on rotifer *Brachionus plicatilis* at a density of 16 pcs/ml. Rotifers were previously fed on the green algae *Nannochloropsis oculata*. These algae were maintained in larval rearing tanks at a concentration of 500,000 cells/ml during the 2nd and 3rd days and after that its concentration was decreased to 300,000 cells/ml until the end of experiment.

Zoo-technical methods:

Larval were sampled on the 7th, 14th and 21st days from different treatments in the tanks using 1-liter beaker after aeration was stopped. Swim-bladder inflation, total body length, and rotifer's uptake were monitored every week. Total body length was measured using a sample of 30 pcs. Of larva while a sample of 50 pcs. was used to detect the percentage of swim-bladder inflation. Fish survival rate was monitored at the end of the experiment not every week to avoid fish stress resulted from sampling. This experiment lasted 22 days from the 2nd day after hatching to day 23. Measurements mentioned were calculated according to the following formula:-

Specific growth rate (SGR) in length = 100 $(\ln_{FL} - \ln_{IL}) / T$

Where: $_{FL}$: mean length at the end of the experiment

$_{IL}$: mean length at the beginning of the experiment

T: time in days (Jauncey and Ross, 1982)

Fish survival rate (%) = 100 (FN / IL)

Where: FN: number of fish at the end of the experiment

IL: number of fish at the beginning of the experiment

(Akatsu *et al.*, 1983)

Swim-bladder inflation (%) = 100 (LS /TL)

Where: LS: no.of larvae having swim-bladder

TL: total no.of larvae tested

Rotifer's uptake = FD - ID

Where: FD: density of rotifer (pcs/ml) in a day

ID: density of rotifer (pcs/ml) in the previous day at the same time.

Water quality:-

Water temperature and dissolved oxygen were measured daily using oxygen meter (SPER Scientific), while pH values were recorded twice a week using advanced pH meter 840035 (SPER Scientific). Water salinity was measured using temperature compensated refract meter.

Statistical Analysis:

Statistical analysis was performed using a computerized Package Software (SPSS Version 10 program) and treatments were evaluated at a 0.05 probability. Analysis of variance, one–way ANOVA was used to evaluate The best regression equation between water salinity and larval length was calculated at the best significance value and the highest RSQ using SPSS statistical program version 10.The differences within treatments were tasted using LSD used at a 0.05 probabilities (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Water quality:

The ranges and means of the water quality parameters during the experimental period (21 days) were within suitable limits for larval rearing tanks: salinity was 15, 25,and 35 ppt for the previous treatments; temperature ranged between 17.6-20.1°C**;** dissolved oxygen ranged between 6.4-9.2 ppm and pH 8.2-8.50 (Akatsu *et al* 1983) .

Swim-bladder Inflation:

The results of the present study (Table 1. and Fig. 1) revealed a highly significant ($p \leq 0.05$) effect of decreasing water salinity on the formation of functional swim-bladder inflation along the experimental period. Values of the percentage of S.B. inflation after three weeks were 90.45, 93.10, and 100 % for water salinities of 35, 25, and 15 ppt salinity levels, respectively. The results of the present experiment clearly showed that decreasing water salinity from 35 to 15 ppt salinity levels increased the percentage of swim-bladder inflation. Therefore decreasing water salinity would help the larvae to swim up ward more strongly to fill their swim bladder. Tandler (1993) found that at rearing salinities of 25, 32.5 and 40 ppt, the values of swim-bladder inflation for gilthead sea bream *Sparus aurata* were 92.5, 69.5 and 65%. ppt, respectively. Barnabe, (1990) also confirmed the importance of decreasing the concentration of water salinity to increase the percentage of swim- bladder inflation (over 90%). Aal-Abdul-Elah and Ross (1993) stocked the newly hatched blue-finned sea bream *Acanthopagurs cuvieri* larvae into the experimental tanks without any previous acclimation to the tested salinities (10, 20, 30, 40, and 50 ppt salinity levels. The previous authors concluded that the effect of salinity on swim-bladder inflation attributes to the interaction between the rearing water density and larval density, which will definitely affect sinking rates. Cornacchia (1982) found that the best rate of swim-bladder inflation was obtained at the lowest degrees of water salinity (5 and 10 ppt) compared with higher water salinities. The present results agree with these fundings.

Growth Performances:

Results in Table (1) and Fig. (2a) clearly showed that the growth of fish larvae in length (mm/fish) improved significantly ($p \leq 0.05$) at lower water salinities. The differences in total body length between treatments (especially during the last two weeks) were significant ($P \leq 0.05$). Therefore, the differences between the final values of specific growth rate (SGR % in length) between different treatments were also significant ($p \leq 0.05$). Values of the SGR were 4.2, 4.4, and 4.8 %/day at 35, 25, and 15 ppt salinity levels, respectively (Fig.2b). There is no doubt that, improving the percentage of swim bladder inflation will definitely improve the swimming and hunting abilities of larval. Therefore, feed efficiency and growth rate will be improved, and as a result improved fish survival rate. Holliday, (1969) reported that there are some beneficial effects of is osmotic water salinities to teleosts larval.

Table 1: Effect of different water salinities on swim bladder inflation, growth performances, survival (%), malformation (%), and rotifer's consumption of gilthead Sea bream larvae *Sparus aurata* reared in commercial fish hatchery.

Items	Salinity (ppt)			Average*
	15	25	35	
Initial length - mm	**2.5 .00**	**2.5 .00**	**2.5 .00**	**2.5 ± 0.2**
Swim-bladder Inflation (%)				
1st Week	76.35 a	54.15 b	44.20 b	58.23 ± 6.25
2nd Week	87.50 a	75.95 a	63.35 b	75.60 ± 4.57
3rd Week	100.0 a	93.10 b	90.45 c	94.52 ± 1.80
Final Length (mm)				
1st Week	4.00 a	3.81 a	3.53 a	3.78 ± 0.10
2nd Week	5.58 a	5.13 b	4.75 c	5.15 ± 0.16
3rd Week	6.80 a	6.30 b	6.04 b	6.38 ± 0.15
SGR in length (% / **day)**				
1st Week	6.71 a	6.02 a	4.93 a	5.89 ± 0.10
2nd Week	4.76 a	4.25 b	4.24 c	4.42 ± 0.16
3rd Week	2.82 a	2.93 b	3.43 b	3.06 ± 0.15
Mean SGR in length (% / **day)**	4.76 a	4.40 b	4.20 c	4.46 ± 0.135
Survival rate (%)	61.15 a	52.9 a	47.0 b	53.68 ± 2.82
Malformations (%)	4 .00 b	8 .0 a	10 .0 a	7.3 ± 1.3
Rotifer's consumption (pcs / ml / day)				
1st Week	9.69 a	7.63 a	5.82 b	7.71 ± 0.77
2nd Week	10.86 a	8.22 a	7.85 a	8.98 ±0.89
3rd Week	12.77 a	10.39 a	9.15 b	10.77 ± 0.76

Means (± S.E) in the same row with different superscripts are significantly different ($p < 0.05$)
* Means (± SE) in this column having one or two astric are significantly different at 0.05 and 0.01.
Swim-bladder Inflation (%)= 100 (no. Of larvae having Swim bladder / Total no. of larvae tested)
SGR = 100 (ln Final length - in Initial length.) / Period (days)
Survival = 100 (Final Number of larvae/ Initial Number of larvae)
** Survival rate in each treatment was estimated only at the end of the experiment in order to avoid any stress on fish during the experimental period.
Rotifers Uptake= density of rotifers (pcs/ml.)- density of rotifers (pcs/ml.) in the previous day at the same time

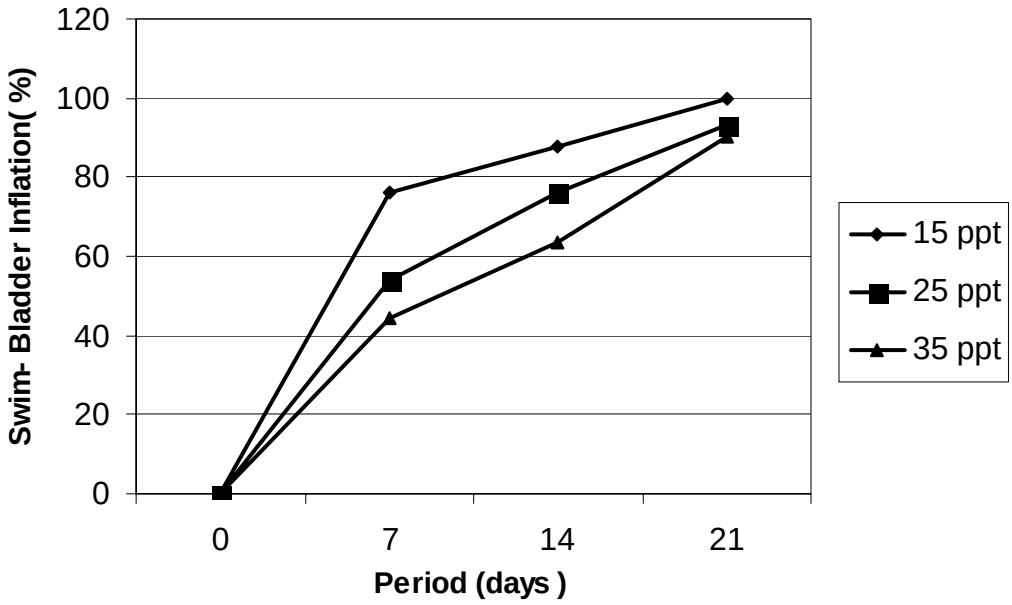

Fig.1: Effect of different salinity levels (15, 25, and 35 ppt) on Swim-bladder inflation of gilthead sea bream larvae *Sparus aurata* reared in commercial hatchery, Alexandria.

These beneficial effects include enhanced swimming ability, reduced metabolic activity, and increased growth rate. This conclusion agrees with the results of recorded in the present study. The effects of reducing water salinity on swim-bladder inflation and growth performances were significantly ($p \leq 0.05$) recorded. In the present study, total body length of fry was nearly similar to that mentioned by Dhert *et al*., (1998) and Tandler (1993). Even in larger sizes of gilthead sea bream fry, reducing water salinity will improve fish growth rate. Tandler (1993) stated that as a result of a salinity reduction from ambient 40 to 25 ppt, growth rate of larval improved by 15%. Cataudella *et al.* (1995) indicated that the fry of gilthead sea bream duplicated its growth as a result of decreasing water salinity during the hot period. Mabrouk *et al.* (2000) found that decreasing water salinity increased growth performance, and condition factor for the fry (0.07-0.9 gm) of gilthead sea bream.

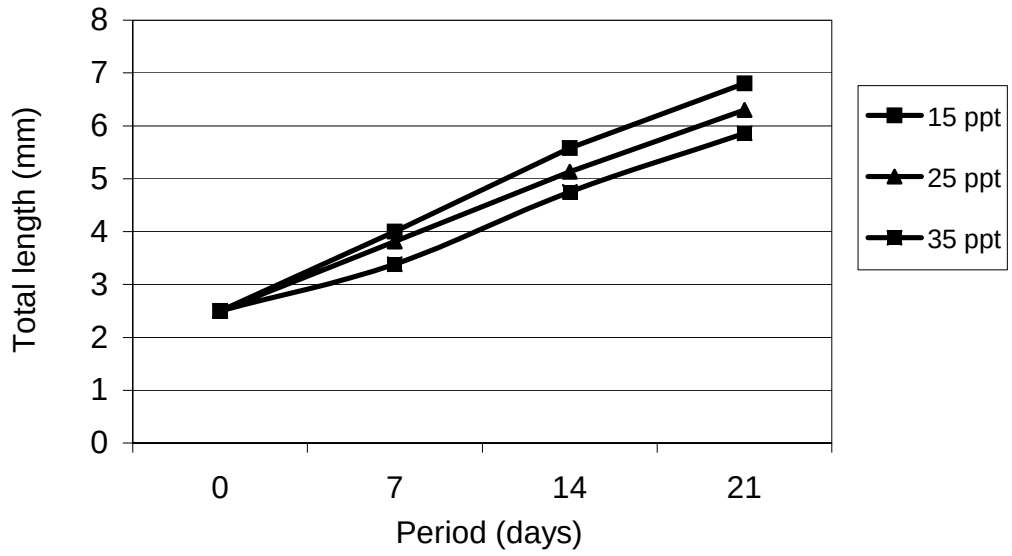

Fig.2a. Effect of different salinity levels (15, 25, and 35 ppt) on the growth in length of gilthead sea bream larvae *Sparus aurata* reared in commercial fish hatchery, Alexandria.

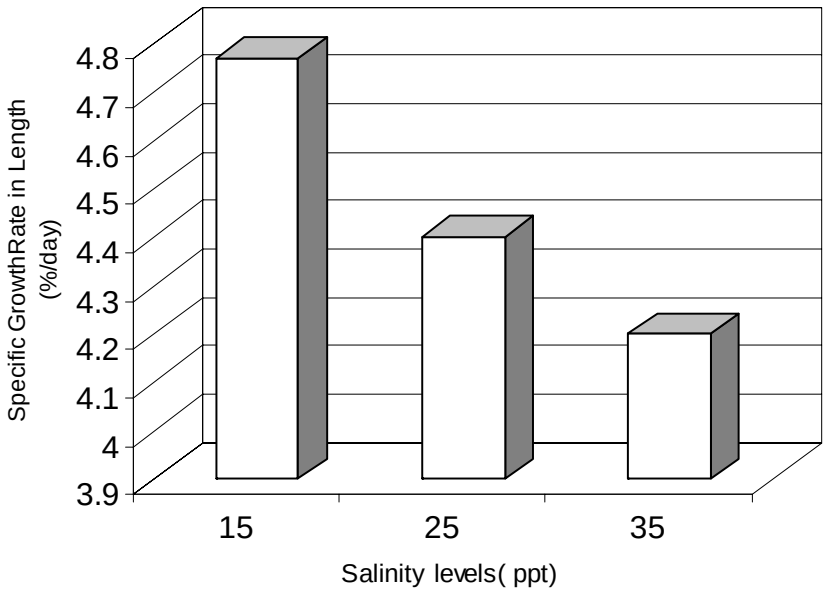

Fig.2b: Effect of different salinity levels (15, 25, and 35 ppt) on specific growth rate % in length of gilthead sea bream larvae *Sparus aurata* reared in commercial fish hatchery, Alexandria

Fish Survival Rate:

Table (1) and Fig (3) show the effect of various water salinities (15, 25, and 35 ppt salinity levels) on the survival rate % of the experimental larvae. Values of fish survival rate after three weeks were 47.0, 52.9 and 61.15 % for 35, 25, and 15 ppt salinity levels, respectively.

The differences were significant ($p \leq 0.05$) between 35 ppt and both 25 and 15 ppt. Survival of embryos and larvae of many marine fish species could be increased at low salinity (Holliday, 1969; Chervinski, 1979,1984). In the present study, the survival rate at 15 ppt was significantly ($p \leq 0.05$) the best. Similar trend observed by Tandler (1993) who found that, the values of survival rates were 18.6, 11.7 and 5.3 % at 25, 32.5 and 40 ppt salinity levels, respectively.

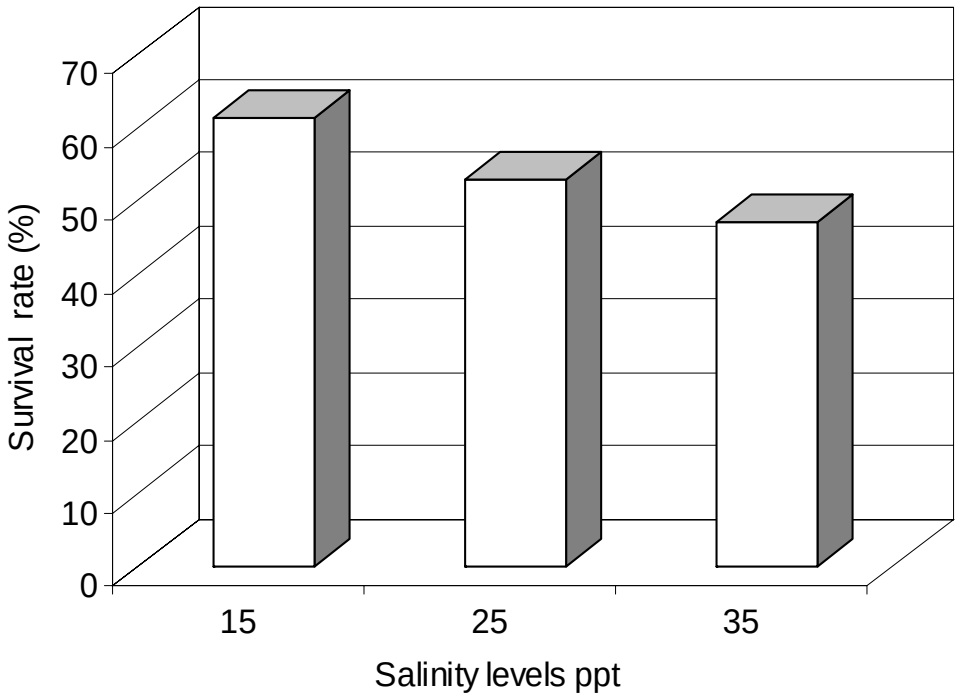

Fig. 3: Effect of different salinity levels (15, 25 , and 35 ppt) on fish survival rate of gilthead sea bream larvae *Sparus aurata* reared in commercial fish hatchery, Alexandria.

Larval malformation:

Values of the percentage of malformations were 10, 8, and 4 % at 35, 25, and 15 ppt salinity levels, respectively (Table1 and Fig. 4) with significant ($P \leq 0.05$) differences between treatments. The results of our experiment clearly show the importance of decreasing salinity levels to reduce the percentage of fish skeletal malformation (lordosis). The relationship between the absence of inflated swim bladder and larval deformities has been stressed (Andrades *et al*., 1996; Goolish and Okutake, 1999; Kihara *et al*.,(2002); Gavaia *et al*., 2002). Water salinity as well as water temperature affects on the swimming performance of larval fish. This attributes to water salinity. There is a significant effect of temperature on the relative critical swimming speed of sea bass (Koumoundouros *et al*., 2002).

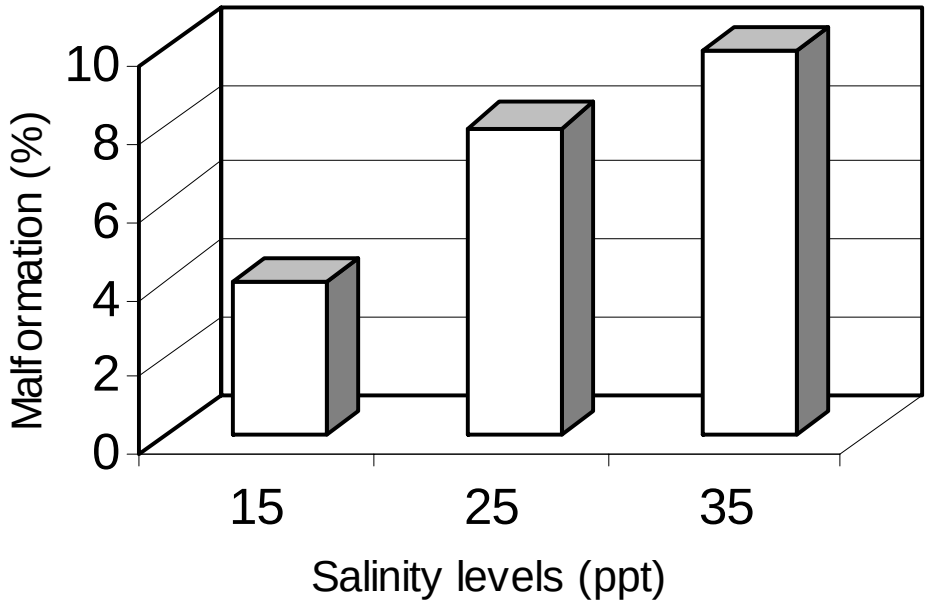

Fig. 4: Effect of different salinity levels (15, 25, and 35 ppt) on malformation of gilthead sea bream larvae *Sparus aurata* reared in commercial fish hatchery, Alexandria.

Rotifer's consumption

The results in (Table 1and Fig 5) clearly show that there is no significant effect of decreasing water salinity on the daily uptake of rotifers. However, a significant differences (P <0.05) were observed between 35 ppt and both 25 and 15 ppt water salinities. The average daily uptake of rotifer at 15 ppt salinity was 9.7, 10.9, and 12.8 pcs of rot./ml/day during the first, second and third weeks, respectively. There is no doubt that, improving the percentage of S.B. Inflation wills definitely improved the swimming and hunting abilities of fry. Therefore, feed efficiency and growth rate will be improved and as a result improved fish survival rate.

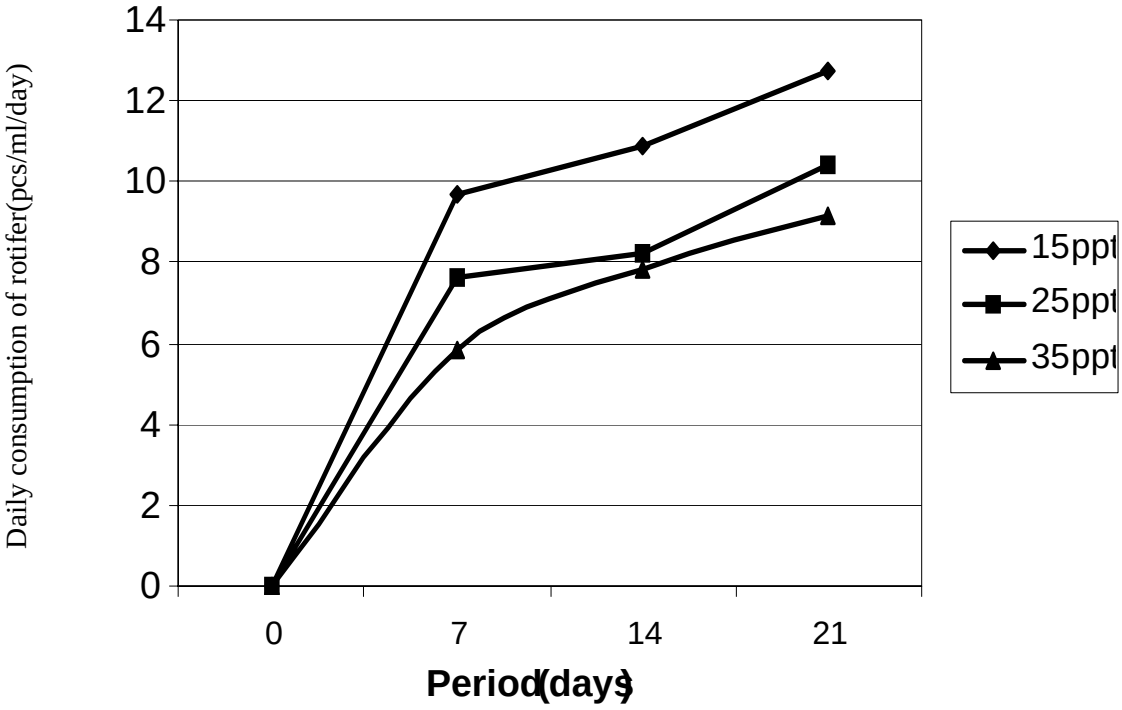

Fig.5: Effect of different salinity levels (15, 25, and 35 ppt) on daily consumption of rotifer of gilthead sea bream *Sparus aurata* larvae reared in commercial fish hatchery, Alexandria.

Finally, it could be concluded that 15 ppt water salinity was the optimum to get the best larval survival (~60%), specific growth rate (4.88), and swim-blaldder inflation (100%) of the gilthead sea bream larval fed rotifer density of 16 pcs/ml.

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