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GROWTH PERFORMANCE OF SEA BASS FRY (*DICENTRARCHUS LABRAX*) UNDER DIFFERENT SALINITIES

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ABSTRACT

This study aimed to investigate the effect of different concentrations of different water salinity (36, 17, 8, 4, 2 ppt. and salinity level is less than 1ppt.) on growth performance and survival rate (%) of sea bass fry *Dicentrarchus labrax*. One thousand and two hundred sea bass fry were randomized stocked at twelve indoor tanks; 4 m^3 each (two replicate/treatment), with an average initial body weight of (2 ± 0.30 g/fish) at the rate of 100 fish / tank. Fish in each tank were hand-fed with commercial diet (40 % crude protein and 485.582 Kcal GE/ 100 g diet). Fish were fed daily at a rate of 15, 10, 5, 4 and 3% of the body weight daily for the (1:2.2); (2.2:3.84); (3.84:9.2); (9.20:12.70) and (12.70) g/fish : until the end of the experiment, respectively. The daily allowances were divided into three meals at 8.00 am; 11.00 am and 2.00 pm. Fish were fed six days a week throughout the experimental period (167 days). The daily amount of feed was re-adjusted every two weeks according to the actual fish biomass in the tanks. The highest significant values of growth performance parameters were observed when sea bass fry were reared at salinities 8 and 36 ppt. Weight gain of the other treatments were negatively affected ($p < 0.05$) by water salinity. The lowest growth performance parameter was observed by salinity level less than 1 ppt. The highest FCR (1.64) recorded at 8 ppt. compared with (1.73) at 36 ppt. and worsens (1.91) at salinity level of less than 1ppt. The same trend was observed for protein efficiency ratio and condition factor where sea bass fry *D. labrax* reared at water salinity 8 ppt. recorded the highest value (1.45 and 1.16), respectively, while treatment 6 (less than 1 ppt. salinity) showed the lowest significant ($P<0.05$) values (1.31 and 1.01), respectively. No mortality was recorded during the experimental period in all treatments. The economic returns studies showed that the total return and net profit were linked to the prices of the raw materials used in the experiment as well as the marketing prices of the fish produced. Total return and net profit showed that the fish reared at 8 ppt. achieved the highest economic return followed by the 36 ppt. and 17 ppt., while treatment 6 (less than 1 ppt.) showed the lowest economic return followed by 4 ppt. Since the feeding cost of these two treatments is 16% higher than the other treatments, which affected the economic returns. However, when evaluating the situation as a high value fish species (like sea bass) with economic value reared in fresh water, this yield is very favorable in terms of cost compared to the selling price.

INTRODUCTION

The European sea bass (*Dicentrarchus labrax* (Linnaeus 1758)) is typically a marine species which spend most of its life in coastal lagoons and estuaries, although it has been observed occasionally in rivers (3ppt. to full strength sea water). It inhabits waters ranging from hypersaline to brackish, and shows oceanodromous behavior. Its euryhaline and eurythmic capability permits this species to show a wide geographic range of distribution and a wide depth range, occurring from shallow waters (2–10 m) to more than 100 m. It is distributed in the Eastern Atlantic, from Norway to Senegal, and in the Mediterranean and Black Sea.

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It has been introduced for culture purposes in Israel, and more recently in Oman and the United Arab Emirates (**Haffray et al 2007**). *D. labrax* inhabit at temperatures between 8°C-24°C (**Froese and Pauly 2012**), although it has been reported that they tolerate temperatures from 5ºC in the northern Mediterranean coastal lagoons, such as Thau, to 27ºC in the lagoon of Biban in Tunisia (**Barnabé 1986**), or even up to 32ºC (**Barnabé 1990**). It tolerates a wide range of salinities, however, can't tolerate freshwater (**Zanuy and Carrillo, 1985; Eroldoğan and Kumlu, 2002; Eroldoğan et al 2004; Eroldoğan et al 2005; Di Trapani et al 2014**). Under natural conditions, reproduction always occurs in marine habitats. From the larva/juvenile transition and beyond (mean length ~15·mm), a fraction of the juvenile cohorts of *D. labrax* enters the brackish waters of the lagoons and estuaries, where they spend most of their early life (**Kelley et al 1988; Pickett and Pawson, 1994**). Juveniles and adults seasonally concentrate at river mouths and in coastal lagoons, and some individuals are known to migrate several km up rivers to freshwater (FW; ~5–15 mOsmol·kg^{-1}**; Barnabé and Guissi, 1993**). Adaptation to various levels of salinity, including FW, involves coordinated physiological responses based on the function of several osmoregulatory organs. It is well established that adult euryhaline teleosts are able to maintain its blood osmolality at about 300–350 mOsmol·kg^{-1} in the range of tolerable salinities, due to an effective hydro-mineral regulation occurring mainly at the gill, urinary system, intestine and integument levels (**Evans et al 1999; Greenwell et al 2004; Varsamos et al 2001**).

The objectives of this study were thus: (1) Evaluate the growth performance of pre-fattening sea bass *Dicentrarchus labrax* at different water salinities; (2) To determine different abilities of osmoregulation at salinity less than 1 ppt. compared with other salinity levels; and (3) Economical evaluation of sea bass *Dicentrarchus labrax* cultivation by using different water resources available under Egyptian conditions.

MATERIALS AND METHODS

The present experimental work has been carried out in K21 Marine hatchery belongs to General Authority for Fish Resources Development (GAFRD), Al-Agami, Alexandria, Egypt.

Experimental Facility and design

Before starting the experiment, tanks was drained completely, disinfected by chlorine then cleaned by fresh water several time and were exposed to sun radiation for two days. The experimental fiberglass tanks were distributed randomly to six treatments each treatment was replicated in two tanks (4m^3 water volume / tank). Acclimation was done for approximately 15 days by lowering the salinity with fresh water until the desired salinity levels (36, 17, 8, 4, 2 and <1 ppt.) were reached. Throughout the study, sea water was mixed daily with fresh water, and aerated with an air-blower connected to stone air-diffuser when all test salinities were adjusted with the refractometer. Sea Bass fry (*Dicentrarchus labrax* L., 1758) with average initial weight (2.0± 0.30) g/fish were stocked at a rate of 25 fish/m^3 (100 fish/tank).

Experimental diets

Composition and proximate analysis (%) of commercial diet used in the study presented in (40 % protein and 485.58 kcal GE/100g diet) **(Table 1)**. Diet ingredients were the pellet size approximately was 0.3 mm in diameter and 2 mm in length. Fish in each tank were hand-fed with the experimental diet. The feeding rate were 15, 10, 5, 4 and 3% of the body weight daily for the (1:2.2); (2.2:3.84); (3.84: 9.2); (9.20:12.70) and (12.70) g/fish to the end of the experiment, three times daily (8.00am ; 11am and 2.00 pm) for six days a week throughout the experimental period (167 days). The daily amount of feed was re-adjusted every two weeks according to the actual fish biomass in the tanks.

Measurements of fish performance, survival rate and condition factor

Samples were taken at stocking and at harvest to estimate the average daily gain (ADG, g/fish/day), specific growth rate (SGR, %/day), protein efficiency ratio, feed conversion ratio, survival rate and condition factor were calculated according to the following formula:

1- **Average daily gain (ADG)** = *Fw – Iw / T*
   Where: Fw: mean weight at the end of the experiment
   Iw: mean weight at the beginning of the experiment
   T: time in days

2- Specific growth rate (SGR %/ day) = *100 (ln Fw - ln Iw) / T*

Where: Fw: mean weight at the end of the experiment

Iw: mean weight at the beginning of the experiment

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

3- Protein efficiency ratio (PER)= weight gain(g/fish)/protein intake , **(Bagenal, 1978).**

4- Feed conversion ratio (FCR) = feed intake / weight gain, **(Jhingran, 1991).**

5- Fish survival rate (%) = 100 (Fn / In)

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

In: number of fish at the beginning of the experiment **(Akatsu et al 1983).**

6- Condition factor (K) =100*(W/L^3)

Where: W: Final mean body weight (g).

L: Mean standard length (cm).

Experimental Diet

Experimental diet were prepared by using the local available raw material in market according to (**NRC, 1993) (Table 1)**,

Table 1. Composition and Proximate analysis (%) of commercial diet used in the study.

Ingredient (%)	%
Fish meal (72% CP)	20.00
Soybean meal (44% CP)	45.00
Corn Gluten Meal	7.00
Rice bran	10.00
Yellow corn	4.00
Vegetable oil	10.10
Fish oil	0.50
Salt	0.50
$CaCO_3$	1.00
Mono calcium sulphate	0.50
Binder (Bintonite)®	1.075
Anti-oxidant and Anti toxic	0.025
Vitamin and mineral premix[1]	0.30
Total	**100.00**
Chemical composition (%)	
Crude protein	40
Ether extract	15
Crude fiber	4.8
Ash	6.7
NFE (%)	28.6
Gross Energy (kcal / 100g diet)[2]	485.582
P/E ratio[3]	82.37

[1]Vitamin and mineral mixture premix are presented in **Table 2**
[2]GE=Gross Energy: - Gross energy was calculated as 5.65, 9.45 and 4.12 Cal. per gram dry matter of protein, lipid and carbohydrate, respectively after **(NRC, 1993)**.
[3]P/E ratio = Protein to energy ratio mg crude protein/Kcal GE

Table 2. Vitamins and minerals of the mixture used in the experimental diets (/kg)

Item	Unit / kg mixture	Item	Unit / kg mixture
Vitamin A	4.8 .I.u.	Folic acid	400 mg
Vitamin D3	0.8 .I.u.	Biotin	20 mg
Vitamin E	4.0 gm	Choline chloride	200mg
Vitamin K	0.8 gm	Copper	4.0 mg
Vitamin B1	0.4 gm	Iodine	0.4 mg
Vitamin B2	1.6 gm	Iron	12.0 mg
Vitamin B6	0.6 gm	Manganese	22.0 mg
Vitamin B12	4.0 gm	Zinc	22.0 mg
Pantothenic acid	4.0 gm	Selenium	0.04 mg
Nicotinic acid	8.0 gm		

* Broiler premix was obtained from Pfizer , Egypt

Water quality parameters

Water quality parameters in the experimental circular fiberglass tanks were determined as follow:

The concentration of total ammonia-nitrogen was measured at weekly according to **Boyd and Lichkoppler (1979).**

Nitrite was monitored weekly using a model PLN code test kit from LaMotte (**Chestertown, Maryland, USA**).

Water temperatures were recorded daily in each circular fiberglass tanks .Also, dissolved oxygen was measured daily by oxygen meter and pH using pH meter. Water salinity was measured in different treatments daily by the refractometer.

Over the experimental period of 167 days, the temperature, oxygen, pH, total ammonia-nitrogen (TA-N mg/l) and nitrite (NO2-N, mg/L) were (25.19 ± 4.00°C); (7.18 ± 0.7mg/l); (6.8±0.2); (0.01±0.002 mg/L) and (0.13±0.002 mg/L) respectively.

Economical study

Economical analysis was done at the end of the study. The total return (value of fish harvest), total costs (value of fingerlings, artificial diets, and water exchange cost), and the net estimated return [total return- total costs] were calculated according to **(Green et al 1995).**

Statistical analysis

The statistical analysis was applied according to **Steel and Torrie (1980)** on the collected data using a **SAS program (1998).** Differences between means were tested for significance according to Duncan's multiple rang test **(Duncan, 1955).**

The following model was used to analyze the obtained data:

Yij=u+Ti+eij

Where:

Yij =observation.

U = the overall mean.

Ti= the effect of treatment.

eij= random error.

RESULTS

Growth parameters

The effects of different salinity levels (DSL) on growth performance of pre-fattening sea bass (*D. labrax*) were summarized in **Table 3**.

Growth performance of sea bass fry *D.labrax* reared in water salinity at 8 ppt. had higher value than those at normal salinity 36 ppt. (42.75 g/fish) **(Table 3)** and were significantly affected by water salinity (p<0.05). The highest final weights were displayed at 8 ppt. (44.25 g/fish), 17 ppt. (39.90 g/fish) and 4 ppt. (38.25g/fish), respectively. The fish reared in 2 ppt. (35.5 g/fish and <1 ppt. (31.10 g/fish) had the second best weight at the end of the experiment, respectively. Average daily gain at <1, 8 and 36 ppt. were 0.18, 0.26 and 0.25 g/fish/day, respectively. Specific growth rates at <1 and 36 ppt. were lower than those displayed at salinity below 8 ppt. **(Table 3 and Fig. 1)**. The specific growth rates at <1, 8 and 36 ppt. were 1.63, 1.81 and 1.79, respectively.

Feed utilization parameters

The effect of different salinity levels on feed utilization parameters and condition factor of sea bass *D. labrax* were summarized in **Table 4 and Fig. 2.** Feed conversion ratio improves at salinity level 8 ppt. (1.64) compared with normal salinity level 36 ppt. (1.73) and were significantly affected by water salinity (p<0.05) followed to salinity levels at 17 ppt. (1.73), 4 ppt. (1.71), 2ppt (1.74) respectively, and worsens at salinity level of less than 1ppt (1.91). Protein efficiency ratio of sea bass *D. labrax* fry reared in water salinity at 8 ppt. (1.52) had higher value than those at normal salinity 36 ppt. (1.45) **(Table 4)** and were significantly affected by water salinity (p<0.05), while the lowest value recorded when fish reared in >1 ppt. (1.31). The same trend was observed for the condition factor where sea bass fry *D. labrax* reared in water salinity at 8 ppt. recorded the highest value (1.16) with significant differences (P≤0.05) with other treatments , while the lowest significant one (P<0.05) was recorded (1.01) treatment 6 where is salinity less than 1ppt .

Economical Evaluation

The effect of different salinity levels on total income and net return of sea bass fry *D. labrax* were summarized in **Table 5**. The total income and net return were related greatly to the cost of inputs materials, which used in this study and to marketing price of the product.

Sea bass fry *D. labrax* reared in water salinity at 8 ppt. achieved the highest net return than 36 ppt. and 17 ppt., while the lowest net return was shown by salinity at <1 ppt. then salinity at 2 ppt., it increased about 16% in the amount of feed comparing at 8 ppt. (the best result), but compared to use fresh water for cultivate valuable fish like Sea bass it is an important result.

Table 3. Effect of different salinity levels (DSL) on growth performance of sea bass fry (*D. labrax*).

DSL (ppt.)	Body weight		Total weight gain (g/fish)	ADG (g/fish/day)[1]	SGR (%/day)[2]
	Initial (g/fish)	Final (g/fish)			
36	2.15	42.75^{b}±0.25	40.60^{a}±0.20	0.25^{a}±0.001	1.79^{a}±0.01
17	2.40	39.90^{bc}±0.10	37.50^{b}±0.10	0.23^{b}±0.002	1.68^{ab}±0.06
8	2.15	44.25^{a}±0.75	42.10^{a}±0.75	0.26^{a}±0.001	1.81^{a}±0.03
4	2.20	38.25^{cd}±0.0.25	36.05^{bc}±0.0.25	0.22^{bc}±0.002	1.71^{bc}±.0.05
2	2.25	35.50^{d}±0.50	33.25^{d}±0.50^{c}	0.20 ^{d}±0.001	1.65^{c}±0.02
<1	2.05	31.10^{c}±0.90	29.05^{d}±0.95	0.18^{d}±0.001	1.63^{d}±0.04

a,b,….etc., mean in the same column bearing different superscript are significantly different at (P< 0.05).

[1]ADG = Average daily gain (g/fish/day)

[2]SGR= Specific growth rate (%/day)

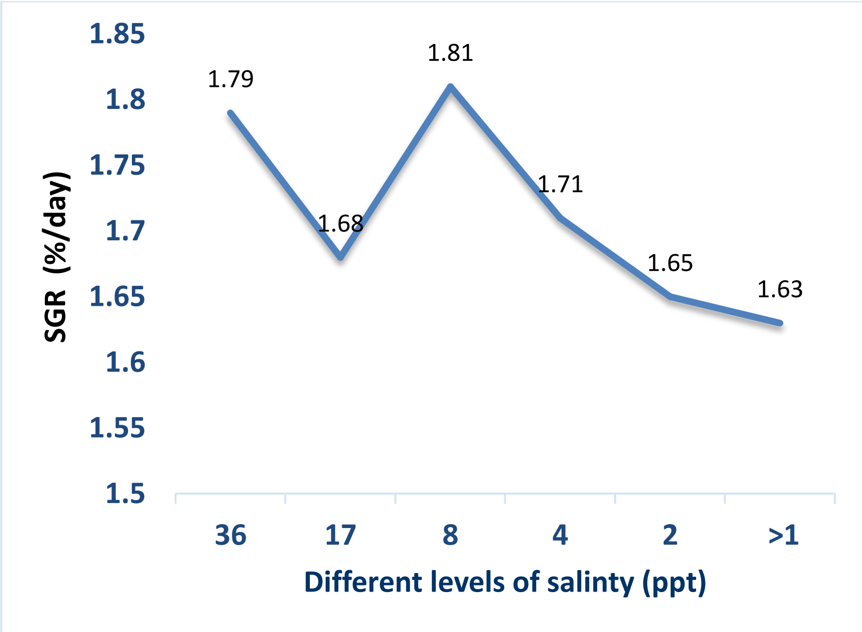

Fig. 1. Effect of different salinity levels on specific growth rate (%/day) of sea bass fry (*D. labrax*)

Table 4. Effect of different salinity levels (DSL) on feed utilization parameters of sea bass (*D. labrax*) fry.

DSL (ppt)	FI (g/fish)	FCR	PER	FBW	FBL	K
36	70.24±4.85	1.73^{ab}±0.01	1.45±0.01	42.75^{b}±0.25	15.59^{a}±0.13	1.13±0.02
17	64.88±4.83	1.73^{ab}±0.09	1.45±0.01	39.90^{bc}±0.10	15.59^{a}±0.13	1.09±0.02
8	69.04±4.84	1.64^{b}±0.01	1.52±0.03	44.25^{a}±0.75	15.59^{a}±0.13	1.16±0.03
4	61.29±4.67	1.71^{ab}±0.02	1.47±0.02	38.25^{cd}±0.0.25	15.59^{a}±0.13	1.10±0.02
2	57.86±4.56	1.74^{ab}±0.03	1.44±0.02	35.50^{d}±0.50	15.59^{a}±0.13	1.07±0.01
<1	55.49±4.54	1.91^{a}±0.07	1.31±0.01	31.10^{c}±0.90	15.59^{a}±0.13	1.01±0.01

a,b,….etc., mean in the same column bearing different superscript are significantly different at (P< 0.05).
FI=Feed intake; FCR = Feed conversion ratio; PER= Protein Efficiency Ratio,
FBW= Final body weight; FBL=Final body length and K=condition factor.

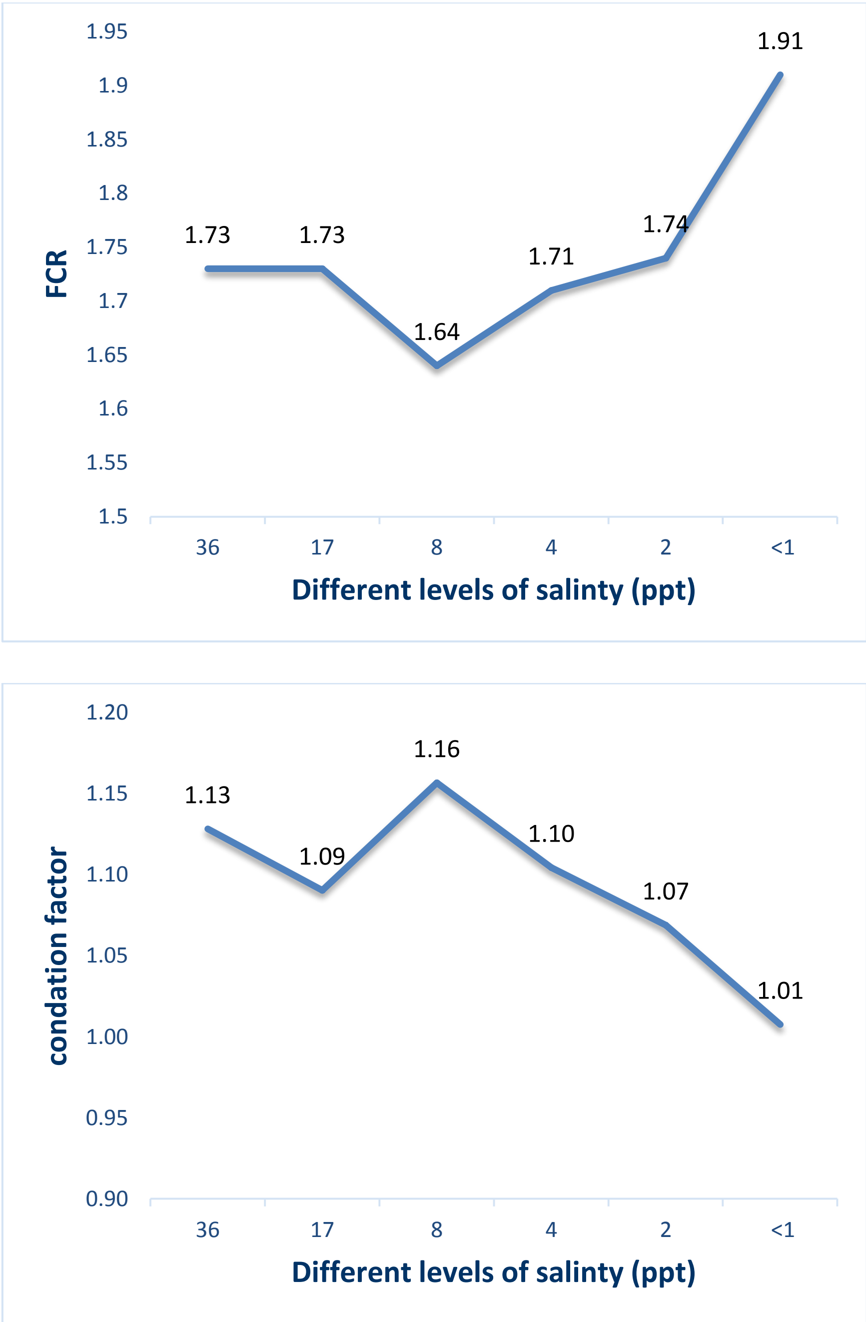

Fig. 2. Effect of different salinity levels on feed conversion ratio and condition factors of sea bass fry (*D. labrax*).

Table 5. Effect of different salinity levels (DSL) on economical evaluation parameter of sea bass (*D. labrax*) fry;

DSL (ppt.)	Economical Evaluation
36	$68.96^{a} \pm 1.01$
17	$64.46^{a} \pm 1.01$
8	$70.73^{a} \pm 1.01$
4	$62.56^{b} \pm 1.01$
2	$57.28^{c} \pm 1.01$
<1	$53.46^{c} \pm 1.01$

a,b,….etc., mean in the same column bearing different superscript are significantly different at (P< 0.05).

DISCUSSION

The results of growth performance and feed utilization parameter were in agreement with several authors like; **Dendrinos and Thorpe, (1985); Conides and Glamuzina, (2006); Rubio et al (2005),** who found different growth rates and different feed conversion ratios when different environmental conditions were applied. Their results showed that salinity levels between 25-30 ppt. were the optimum for the growth rate of European sea bass. They specifically recorded that 18 ppt. salinity level at 19°C provided optimum conditions for feed intake and growth performance. These results are closely consistent with the findings found in the present study. All of the aforementioned studies also stated that the fish need more energy for osmoregulatory process at low salinity levels. However, whether or not all sea-bass are able to adapt long-term to fresh water is still unclear; as described by different experimental studies **(Cataudella et al 1991; Allegrucci et al 1994; Jensen et al 1998; Lemaire et al 2000; Varsamos et al 2002).** Also sharing opinion of **Eroldoğan and Kumlu, (2002)** who stated that; juvenile and young sea bass were not only able to survive successfully in fresh water but could also grow well in the medium salinity. Also our results agreed with the results of **Ercan et al (2015)** who found that the highest growth performance was achieved when European Sea Bass fish reared in10 ppt. water salinity. Our results do not agree with the findings of **Dendrinos and Thorpe (1985)** who observed an immediate loss of appetite and heavy mortality in fish gradually acclimated to fresh water over a period of two weeks. They found that fish growth rate was decreased in the order of decreasing water salinities. Further attempts by **Eroldoğan and Kumlu (2002)** to acclimatize European sea bass fish into fresh water again failed**.** In the present study, however, neither juvenile nor young fish had any difficulty in acclimation to fresh water, hence, euryhaline capability does not seem to be affected by fish size, confirming the suggestion of **Jensen et al (1998).** It is difficult to see why there is a clear difference in tolerance to fresh water between the sea bass stocks used by **Dendrinos and Thorpe (1985)** and those used in our experiment. It is known that inherent differences to salinity tolerance exist in shrimp populations located in different parts of the world **Harpaz and Karplus (1991)** and **Kumlu and Jones (1995).** This type of environmental adaptation may also be true for different geographical strains in fish. In fact, a difference in tolerance to salinity has already been suggested between the European sea bass populations inhabiting marine and lagoon ecosystems **Kumlu and Jones (1995).** It was also found that hatchery juveniles tolerate direct transfer to low salinities better than wild juveniles **Marino et al (1994).** Also not partly agreed with **Bernardino and Fernandes (2016)** who said that; after two months of study, there was no growth differences in different salinities, meaning that fish grew in a similar way in salinities 3, 6 and 12, 5. Further studies are necessary in order to access growth in a longer period.

CONCLUSION

In general, the results of this study indicate that it can use different levels of salinity for sea bass Pre-fattening stage with the advanced growth performance in brackish water (salinity 8 ppt.) up to sea water, feed utilization and increase economical return. The present study gives the opportunities to the marine hatchery to sell Sea bass fingerlings to brackish water farms to produce high value fish species like Sea bass (*Dicentrarchus labrax* L., 1758), which is reflect on the sustainability of investment opportunities in aquaculture sector using a different levels of salinity.

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