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The first comparative study on the growth performance of European seabass (*Dicentrarchus labrax*, L. 1758) and gilthead seabream (*Sparus aurata*, L. 1758) commercially farmed in low salinity brackish water and earthen ponds

Altan O.[1*]

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Abstract

In this study, 50 000 European seabass and 50 000 gilthead seabream with an average wet weight of 1.6 g were cultivated during 600 days under low water salinity conditions (7‰) of which getting out from underground at fixed 19°C, being produced in earthen ponds under commercial production conditions. From the beginning to the end of the experiment, the same fish feeds were used for both species throughout the study, and when European seabass reached 328.4±22.98 g, gilthead seabream reached to 369.12±24.11 g. At the end of the experiment, while the feed conversion rate (FCR) was calculated as 1.72±0.06 for European sea bass, it was calculated 1.53±0.03 for gilthead sea bream. Protein efficiency ratios were 1.24±0.17 for European seabass, and 1.40±0.06 for gilthead seabream. Significant differences were found between two species in terms of live weight and FCR ($p<0.05$), while no difference was found related to the specific growth rate ($p>0.05$). The results showed that gilthead seabream taken into earthen ponds and low salinity brackish water was able to reach 300 g and over live weight with faster and lower FCR values compared to European sea bass in the certain time.

Keywords: Gilthead seabream, *Sparus aurata*, European seabass, *Dicentrarchus labrax*, Earthen ponds, Brackish water, Low salinity.

1-Department of Aquaculture, Faculty of Fisheries, Ege University Bornova – Izmir, Turkey
*Corresponding author's Email: ozgur.altan@ege.edu.tr

Introduction

Farming of European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) is extremely important in economic terms in the world, particularly in Europe and the Mediterranean coastal countries. Gilthead seabream production in all European countries reached 147 649 tons and European seabass production reached 158 479 tons by the end of 2015. Considering that the total production of aquatic products in these countries has reached 2 359 705 tons, it is seen that European seabass and gilthead seabream production constitutes 13% of this amount (FEAP, 2017). There are numerous studies on both species, in terms of nutrient requirements, optimum growth and development rates and special requirements in culture conditions (Hidalgo *et al.,* 1987; Hidalgo *et al.*, 1988; Peres and Oliva-Teles, 1999; Oliva-Teles, 2000; Watanabe, 2002).

If the aquaculture environment conditions and nutrient requirements of the European seabass and gilthead seabream are examined, it can be seen that both species have similar biological and feeding characteristics, they can survive between 3-35‰ salinity levels, are tolerant to the temperature changes and can be adapted to commercial fish feed rapidly at the juvenile stage. Due to these features, many hatcheries and net cage farms are capable to produce European seabass and gilthead seabream at the same time. Nutritional requirements and commercial feed contents of both species are very similar. Both species need 48-52% crude protein and 14-16% crude fat at the juvenile stage, whereas these requirements decrease to 43-45% crude protein and 18-20% crude fat during the grow-out phase (Oliva-Teles, 2000; Watanabe, 2002; Ghisaura *et al.,* 2014). When taking the intensive areas in which these species are cultivated into consideration, the first grow-out environment that comes to mind is net cages; however, because the coastal areas and the bays in where fish farmers have been producing European seabass and gilthead seabream, started to abandon in recent years; because of the factors such as climate change, pollution and tourism investments, the earthen pond breeding has just started to reevaluate and find its place economically. According to this general consideration, European seabass and gilthead seabream farming in the earthen ponds can be done in the environments were located next to the sea with the salinity level of 6-9‰, which is called “brackish water”, far away from the sea (Barnabe and Guissi, 1993; Klaoudatos and Conides, 1996; Boeuf and Payan, 2001).

In this study, the growth and feed efficiency of European seabass and gilthead seabream were evaluated in the commercial earthen pond farm conditions with low salinity.

Materials and methods

Fish farm and environmental conditions

This study was carried out in a private earthen pond farm where is located in Milas – Turkey, for 600 days between April 2016 and November 2017. In this study, four earthen ponds were used which each of them had 4100 m^3 volume. Water was pumped up from 25 m depth by using a moto-pump and was given to ponds with open water principles. The temperature and the salinity of the underground water were fixed constant 19 °C and 7‰ respectively throughout the year in the farms. In the study, pedal aerators were used from midnight to the morning to increase the oxygen level of the ponds between May and September when the water temperature has been increased.

Study area, fish, trial feeds, growth and feed performance evaluation

For this study, 50 000 European seabass with an average wet weight of 1.6±1.2 g and 50 000 gilthead seabream with an average wet weight of 1.6±0.7 g were obtained from a private marine fish hatchery in Mugla-Turkey. Both species were distributed to four ponds, which would be 25 000 fish in each pond (two replicates for each species). The fish was not fed on the first three days of the study, and it was accepted as the process of adaptation to the experimental conditions.

Throughout the study, European seabass and gilthead seabream were fed with the same feed, and extruded pellet no 2-3 and extruded pellet no 4-5 were used which were manufactured by a private fish feed plant. The first feeding was initiated with pellet no 2-3 and then having the fish reached an average of 100 g wet weight, feeding was continued with pellet no 4-5. The nutritional composition of the feeds supplied by the relevant feed manufacturer is shown in Table 1.

Table 1: Nutritional composition (%) of the commercial fish feeds.

Content	Pellet no. 2 and 3	Pellet no. 4 and 5
Moisture	12	12
Crude Protein	48	45
Crude Fat	16	20
Crude Cellulose	2	2.5
Crude Ash	12	12
Additives	10	8,5

All the fish were fed three times a day at 8:30, 12:00 and 16:30 up to an average weight of 100 g, and then after this weight, at 09:30 to 16:00 twice a day *ad libitum*. Fish were fed by two unchanging personnel of the farm from the beginning to the end of the study. At the end of each day, the amount of feed given to the fish was recorded. To monitor the growth of the fish and to obtain data on feed evaluation, 50 fish were taken from the ponds with random sampling once a month, fish were anesthetized using 2-phenoxyethanol (1 ml L^{-1} water), and average wet weight was monitored by using a 0.01 g sensitive scale. Daily temperature and dissolved oxygen values in the ponds were measured and recorded with YSI Multi-parameter water quality instrument. To calculate the growth and feed evaluation parameters of fish, the following formulas were used;

Specific Growth Rate (SGR)=(ln final weight, g-ln initial weight, g)×100/days

Feed Conversion Ratio (FCR)=feed intake, g/fish weight gain, g

Protein Efficiency Ratio=weight gain, g /crude protein intake, g

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Statistical analysis

The data set was submitted to the analysis of variance (ANOVA) with 95% confidence after the verification of the assumptions for the normality of the data using Kolmogorov-Smirnov test. The homogeneity of variance was tested with the Levene test. Once these requirements were fulfilled, the mean values were approached the average comparisons using the Student-Newman Keuls test. In the case of non-parametric data, a Kruskal-Wallis H test was performed. All the statistical analysis was conducted using Statistical Package for Social Science (SPSS for Windows; v19.0, USA) and differences were considered statistically significant when $p<0.05$.

Results

The average water temperature in the ponds was measured as 18.68±3.91°C throughout the study. The lowest water temperature was recorded at 13.2°C in January and the highest water temperature at 25.11°C in July (Fig. 1).

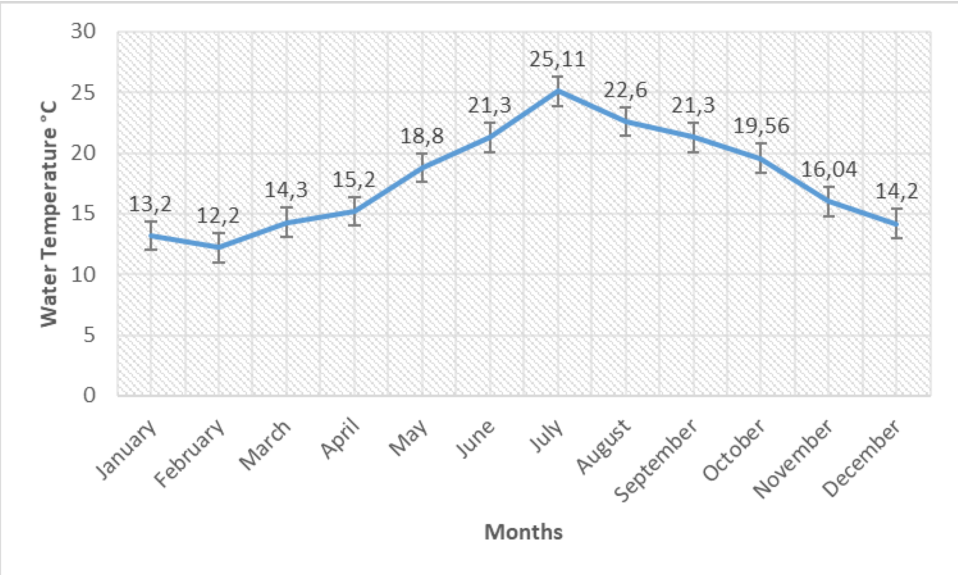

Figure 1. Average monthly water temperature changes in trial ponds in 2015-2016.

The average dissolved oxygen value in gilthead sea bream ponds was measured as 5.79±0.84 mg L^{-1} and the same value was determined as 5.9±0.93 mg L^{-1} in European seabass ponds. The difference between these values was found statistically insignificant ($p>0.05$). In ponds of both species, the lowest dissolved oxygen value was measured in July as 4.75 mg L^{-1} for gilthead seabream and as 4.69 mg L^{-1} for European seabass.

The wet weight, growth, feed conversion, specific growth, and protein efficiency ratios of gilthead seabream and European seabass were given in Table 2 and Fig. 2. Gilthead seabream showed superior growth and development performance compared to European seabass in earthen ponds with the same physical and nutritional characteristics, same feed content, water temperature and dissolved oxygen values. At the end of the 600

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days trial, the weight gain, feed conversion ratio and protein efficiency ratio of gilthead seabream and European seabass were found statistically significant (p<0.05). The specific growth rates of both species showed very similar results and the difference was found statistically insignificant (p>0.05).

Table 2: Wet weight, feed conversion, specific growth and protein effect ratios of gilthead seabream and European seabass.

	Gilthead seabream	European seabass
Initial Weight (g)	1.6±0.7	1.6±1.2
Final Weight (g)	369.12±24.11	328.4±22.98
Gained Wet Weight (g)	367.52	326.8
Feed Conversion Ratio (FCR)	1.53±0.03	1.72±0.06
Specific Growth Ratio (SGR)	0.906±0.05	0.887±0.08
Protein Efficiency Ratio (PER)	1.40±0.06	1.24±0.17

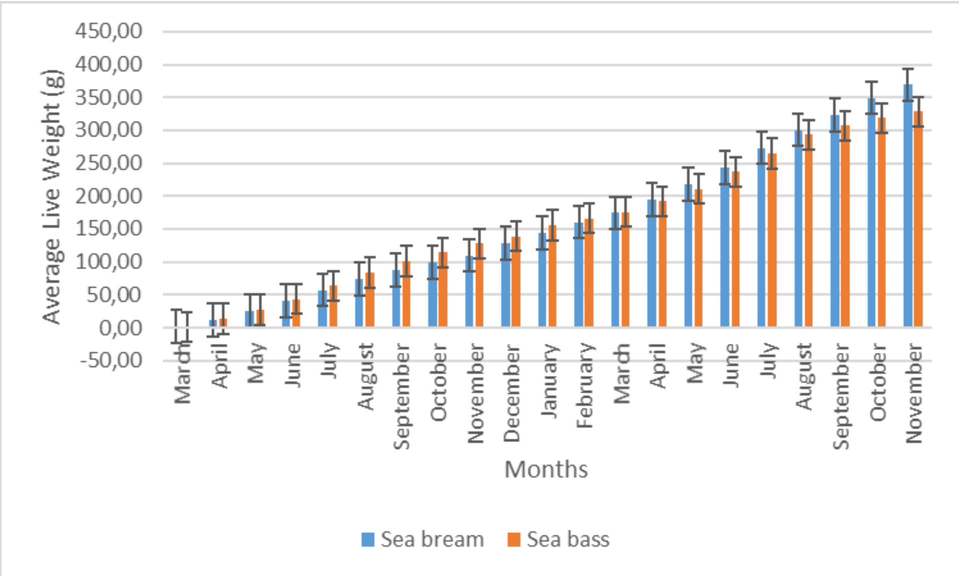

Figure 2: Monthly average wet weight changes of gilthead seabream and European seabass.

While monitoring the growth data of gilthead seabream and European seabass that were stocked in the ponds with the same physical characteristics and fed with the same feed a detail was encountered. Although there was no significant difference during the first 12 months of the study between two species, the growth rate of European sea bass was constantly ahead of the gilthead seabream (p>0.05). With the fish reaching an average of weight 170 g, the growth rate of gilthead seabream increased, the growth performance exceeded European seabass in the last three months of the experiment and this difference was found significant (p<0.05). During the trial, the survival rate was more than 90% and no difference was determined between the experimental groups (p>0.05).

Discussion

Some basic factors affect growth in fish such as water temperature, dissolved oxygen, salinity, age, gender, and other water quality parameters that can be characterized as exogenous factors

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(Laiz-Carrion *et al.*, 2005). Salinity has an important role in intensive marine fish farming. It is stated that gilthead seabream is a euryhaline species, and fish can live in the river mouths with a connection to the sea, lagoons and brackish waters (Cataudella *et al.*, 1995a, b). Similarly, it is foreseen that European seabass can also continue its growth in low salinities. Within the scope of this study, gilthead seabream and European seabass were cultivated at 7‰ salinity and they could be raised over 300 g average weight at the end of 20 months' trial. The FCR data were obtained from this study, were found lower then FCRs of gilthead seabream and European seabass that have grown in net cages in the marine environment and tanks in the laboratory conditions (Ballestrazzi *et al.,* 1998; Basurco *et al.,* 2011; Campos *et al.*, 2017).

In a 12-week feeding study in which the use of fish meal and fish oil at various rates in 1000 liters of polyester tanks, at an average water temperature of 20°C and in 36‰ of salinity was tested. It was exciting that the sea bream reached from 180 g weight to 300 g (Dias *et al.,* 2009). Under fully controlled laboratory conditions, it was possible that gilthead seabream with an average weight of 100 g can reach an average weight of 410 g in 14 weeks between 18-25 °C water temperatures (De Francesco *et al.,* 2007). The other study reported that gilthead seabream and European seabass reached from 190 g to 300 g more or less within the same period; however, feed evaluation efficiency occurred 72% higher rates in European seabass (Tibaldi *et al.,* 2006). Sadek *et al.* (2004) stated that gilthead sea bream fed for eight months at 25‰ salinity could exhibit an average weight increase of 100 g.

Earthen ponds have always been noteworthy as aquaculture environments where fish contains a large part of the living material they are fed in nature within their structure, hence, providing lower feed conversion. In the research findings of Chim *et al.* (2008) obtained by testing two farming environments at the same time by placing portable net cages in the earthen ponds, reported that the shrimp fed directly with the feed material in the earthen ponds are more successful in terms of feed conversion and feed evaluation rates than those cultivated in net cages. Similarly, while mentioning the importance of live food resources in earthen ponds, Lacerda *et al.* (2009) draws attention to the importance of biological accumulation in this type of pond farming and emphasize the need to constantly analyze the sediment structure during aquaculture works.

This is the first study to compare the growth and feed evaluation data of gilthead seabream and European seabass, which are produced in commercial production conditions and low salinity earthen ponds until they are reached to the market size. It is clear that both species have a very high economic importance for the Mediterranean countries can be cultivated commercially both in earthen ponds and in low salinity brackish waters. This study is an important guide in terms of showing the fact that European sea bass grows faster than

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gilthead sea bream in the juvenile stage. When the farmers preferred gilthead seabream to European seabass in the earthen ponds and low salinity and will know that gilthead seabream covers the period in the process from the juvenile stage to the marketing stage and reach the 300 g average weight in total earlier than European seabass.

On the other hand, the results of this study demonstrated that earthen ponds could be one of the possible alternatives to grow gilthead seabream and European seabass in net cages. There is an accepted fact that because of climate change, water temperature, other water quality parameters and environmental conditions are changing rapidly day by day. Under this type of circumstance, fish farmers will face some difficulties to plan their productions. Contrary to these negative effects, earthen ponds include brackish water even low salinity can provide a stable aquaculture environment to the producers.

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