
**E-ISSN: 2347-5129**
**P-ISSN: 2394-0506**
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(6): 336-340

www.fisheriesjournal.com
Received: 05-09-2018
Accepted: 10-10-2018

**Aysun Kop**
Department of Aquaculture, Faculty of Fisheries, Ege University, TR-35100 Bornova/ Izmir, Turkey

**Correspondence**
**Aysun Kop**
Department of Aquaculture, Faculty of Fisheries, Ege University, TR-35100 Bornova/ Izmir, Turkey

# Growth performance of European seabass (*Dicentrarchus labrax*) fed with yeast feed in earthen ponds and its effect on feed cost

## Aysun Kop

**Abstract**
In this study, 450 European seabass (mean weight 25.63 ± 6.95 g and mean length 13.36 ± 1.30 cm) were stocked in six 20 x 25 m. sized earthen ponds. The fish were divided into two groups, as a Fish meal (FM; fishmeal 40%) and an experimental group (Yeast; fishmeal 30% + yeast 10%). At the end of the experiment, there was no significant variation in the growth of fish fed with yeast diets and control diets (P>0.05). In the study, cost calculations were made for both feed ingredient (fishmeal, yeast) and trial feeds. Costs were calculated by the price per kg of dry matter, metabolic energy and protein value of feed ingredients. There was no difference in the Crude Protein / kg cost of the two trial diets, while the cost of the yeast diet was 0.060 c / per kg cheaper than the yeast-free diet.

**Keywords:** European seabass, earthen pond, yeast, fish meal, growth rate, feed cost

## 1. Introduction

Fish nutrition is one of the most important factors affecting the cost of production in commercial fish farms because the nutrition regime can provide good growth while producing feed waste [1].

Protein is considered a major and the most expensive nutrient in feed. Fishmeal is one of the best protein sources for fish feeds as it has an adequate amino acid profile, is a very good source of essential fatty acids and minerals and has a high protein level. Fishmeal, widely used in aqua feeds, mainly produced from small pelagic species such as sardines, herring, anchovies and mackerel. However, governments and consumers are concerned that over-fishing of these species for the feed sector will result in the destruction of marine ecology [2]. Therefore, fishmeal resources are limited and its price has become more expensive over time (1200-1600 US$ per tons) [3]. The discovery of new protein sources to replace fishmeal is one of the most critical subject for world's aquaculture industry [4].

Brewer's yeast (*Saccharomyces cerevisiae*), one of the major probiotics, is a potentially desirable alternate protein source due to its high nitrogen content [5]. For instance, *Saccharomyces cerevisae* contains 45% protein, 8% fat, 13% ash, 10% water and 23% fiber and carbohydrates [6, 7]. It has an excellent amino acid profile and its only deficiency is methionine [6, 7]. Its price was 800 US$ per tons in 2017. Several studies conducted under different production conditions have shown that brewer's yeast can successfully replace a part of dietary fishmeal in different fish species, such as European seabass (*Dicentrarchus labrax*) [5]; Asian catfish, (*Clarias batrachus)* [8]; Nile tilapia (*Oreochromis niloticus*) [9, 10]; Koi carp (*Cyprinus carpio* L., 1758) [11]; *Clarias gariepinus* [7]; Thai Panga (*Pangasianodon hypophthalmus* × *Pangasius bocourti*) [4]; Jian carp (*Cyprinus carpio* var. Jian) [2].

According to the FAO (2017) [12], the European seabass (*Dicentrarchus labrax*) was the first marine but non-salmonid species to be commercially cultured in Europe and at present is the most important commercial fish widely cultured in Mediterranean areas. Turkey (80847 tons), Greece (42556 tons), Egypt (24498 tons), Spain (22956 tons), Italy (6800 tons) and Croatia (5310 tons) are the biggest producers. Generally, off-shore cages are used to produce gilthead sea bream and European sea bass, while earthen ponds are also used for European sea bass production [13]. Oca *et al.*, 2002 [14]. They say that sea bream production, which is similar to sea bass, in coastal facilities can be a viable alternative for different regions along the Mediterranean coast. However, due to the lack of time-dependent water change in the pond and the effect of many variables in earthen pond operation, production processes need to be managed more carefully than other aquaculture systems [15]. Organic substances that accumulate at the bottom of the ponds change the biological and chemical properties of the water in earthen pond plant. This leads to an increase in the amount of plankton in the pond [16]. The accumulation of high amounts of organic material at the base of the pond increases the need for oxygen, which negatively affects fish production [16]. Researchers suggest the cultivation of new species (such as phytoplankton, zooplankton) and probiotic application that can use the organic load that accumulates in the ponds as nutrients [17]. However, in the production of sea bass made in the earthen pond, there is no study on the use of yeast which is an important probiotic in feed.

In this study, European seabass (*Dicentrarchus labrax*) fish were produced in earthen ponds for three months. Only 10% of the fish meal was partially replaced with *Saccharomyces cerevisiae* in the trial diet. The dry matter, energy and protein costs of both the feed and fish meal and the yeast were calculated and compared. In the experiment, the growth performance of the fish was also analyzed and the price / growth efficiency was interpreted.

## 2. Materials and Methods

### 2.1 System management

Six 20 x 25 m (500 $m^2$)-sized earthen ponds, each with an average depth of 1 m were constructed for experimental purposes. Water was taken from the Aegean Sea by pump. A daily water exchange of 15–20% of the pond volume was drained and refilled. The experiment was carried out for three months.

### 2.2 Fish

The European seabass (*Dicentrarchus labrax*) used in the experiment were provided from a farm belonging to a commercial company. The mean initial weights and lengths of these fishes were 25.63 ± 6.95 gr and 13.36 ± 1.3 cm, respectively. The experiments were divided into two groups. One group was the fish meal feed group (FM) and the other group was the yeast feed (Y) group. Each treatment had three replicates. For each repetition, 75 fish were used and a total of 450 seabass were tested.

### 2.3 Feed

The isonitrogenic and isoenergetic experimental feeds were prepared in the Fish Nutrition and Fish Feed Technology Laboratory at the Faculty of Fisheries, Ege University. The raw materials used in preparing the feed and the nutrient content are given in Table 1. During the experiment fish were fed twice a day with a rate of 3% of fish biomass.

**Table 1:** Feed formulation and nutrient composition of the experimental diets

| Feed Ingredients | Rate (%) | |
|---|---|---|
| | **Fish Meal (FM)** | **Yeast (Y)** |
| Fishmeal | 40 | 30 |
| Yeast [a] | - | 10 |
| Soybean meal | 20 | 20 |
| Corn gluten meal | 10 | 10 |
| Wheat meal | 19.3 | 19.3 |
| Fish oil | 10 | 10 |
| Vitamin mix [b]. | 0.3 | 0.3 |
| Mineral mix [c] | 0.2 | 0.2 |
| Binder | 0.2 | 0.2 |
| Total | 100 | 100 |
| Dry matter (%) | 81.46 | 81.56 |
| Crude Protein (%) | 41.53 | 40 |
| Crude Lipid (%) | 14.42 | 13.63 |
| Crude Cellulose (%) | 2.34 | 2.54 |
| Crude Ash (%) | 8.23 | 8.33 |
| Energy ME (kcal/kg) | 3408 | 3298 |

[a]Brewer's yeast (*Saccharomyces cerevisiae*)

[b]Vitamins (mg $kg^{-1}$) diet.: A, 25000 (IU kg $^{-1}$) diet.; $D_3$, 2000 (IU $kg^{-1}$) diet.; E, 100; K., 10; thiamine, 20;B2, 50; Ca pantothenate, 10; nicotinic acid, 300; pyridoxine, 20; folic acid, 8; cyanocobalamin, 0.06; biotin, 1.2; ascorbic acid 150;inositol, 600; colin, 2500.

[c] Minerals (mg $kg^{-1}$) diet.: cobalt, 1; copper, 5; iron, 10; magnesium, 60; manganese, 60; zinc, 70; iodine,

### 2.4 Proximate composition analysis

Analyses of crude protein, crude lipid, moisture and ash in diets were performed according to the standard procedures of AOAC, 2000 [18]. All analyses were done in triplicate.

### 2.5 Water chemistry

Measurement of environmental parameters: Water quality parameters such as DO, temperature, salinity and pH were measured throughout the whole period of the experiment with a YSI Environmental Multipara meter, model no: 2030 and water temperature was measured with a thermometer every day in the morning and afternoon.

### 2.6 Growth performance

Growth performance and feed utilization was calculated as follows:

Daily growth rate (DGR, g $day^{-1}$) = (final weight - initial weight)/T (T: time)

Specific growth rate (SGR) = (*Ln* Wt– *Ln* Wo) X 100 / n (*Ln* is the biological logarithm; Wt: final weight; Wo: initial weight; n: day)

Feed conversion ratio (FCR) = Feed intake (g)/weight gain (g)

Survival rate (%) = 100 X (final number of fish/initial number of fish)

Feed efficiency (FE, %) = 100 x [wet weight gain (g) /feed intake (g fish)].

### 2.7 Costing
Cost estimates were made according to the prices of the feed ingredients and the usage rates of the feed. We also made a price calculation based on the dry matter, energy and raw protein contents of both the fishmeal and the yeast as well as the trial feeds. The prices of fishmeal, yeast and other ingredients were obtained from Turkish feed ingredients' suppliers.

The cost of 1 kg of ME or CP can be calculated with this formula [19]:

Cost/kg Dry Matter (cents) = Cost/ton ($) × 10 ÷ DM%

Unit cost (cents/MJ Metabolic Energy) = cost/kg DM ÷ MJ/kg feed

Cost/kg Crude Protein ($) = Cost/kg DM (cents) ÷ CP/kg x 100

Economic feed conversion rate = FCR x Average feed cost ($) [20]

Total feed cost ($) = Total feed amount x Average feed cost ($) [20]:

### 2.8 Statistical analysis
The student's t-test was used for statistically significant difference. The results are presented as mean ± standard deviation (SD). In addition, the STATISTICA 6 program was used for statistical analysis. Values were statistically significant when $p<0.05$.

## 3. Results and Discussion
### 3.1 Water chemistry
Mean values of water quality were calculated during the experimental period (Table 2). Water temperature (n=180) varied from 12 to $21^0$C depending upon environmental variation. The water pH was 8.1±0.03 (n=45) during the rearing period and salinity was 35.2±0.3 ppt (n=30). Dissolved oxygen levels in the fish ponds were 8.1±0.0.3mgL$^{-1}$ (n=45)

**Table 2:** Mean (±SE) water quality parameters measured in earthen ponds

| ***Parameters*** | ***FM*** | | ***Y*** | |
|---|---|---|---|---|
| | **n*** | **x ±SX** | **n** | **x ±SX** |
| Temperature (°C) | 180 | 18±0.2 | 180 | 18.2±0.6 |
| Dissolved Oxygen (mg L$^{-1}$) | 45 | 8.2±0.03 | 45 | 8±0.02 |
| Salinity (‰) | 30 | 35.1±0.5 | 30 | 35.3±0.2 |
| pH | 45 | 8.1±0.03 | 45 | 8±0.04 |

*n=day numbers

This study was carried out in the earthen ponds and it was seen that seabass could be successfully produced in the conditions existing in the earthen ponds.

### 3.2 Growth and feed performance parameters
Results of growth parameters, feed conversion ratio and survival rate are shown in Table 3.

**Table 3:** Growth and feed utilization of seabass fed the experimental diets

| Parameters | FM±SD | Y±SD |
|---|---|---|
| Initial weight(g) | 25.40±0.49 | 24.86±0.23 |
| Final weight(g) | 56.96±1.25 | 54.19±1.63 |
| Weight gain (g) | 31.56±1.55 | 29.33±1.75 |
| Initial length(cm) | 13.25±0.005 | 13.26±0.001 |
| Final length (cm) | 17.34±0.07 | 17.06±0.21 |
| SGR(% day-1) | 1.34±0.05 | 1.32±0.04 |
| FCR | 1.13±0.10 | 1.15±0.02 |
| FE(%) | 90.29±8.63 | 87.09±1.36 |
| DGR(g day-1) | 0.53±0.03 | 0.49±0.03 |
| Survival rate (%) | 92.00±3.00 | 92.00±2.00 |

Initial body weight (IBW) and length did not differ between treatments ($p>0.05$). There were no significant differences between the average final weights and lengths of the fish fed the Y or FM diet. Weight gain, daily growth rate, feed efficiency and survival rate of fish fed each experimental diet were excellent. FCR of fish fed Y diets showed no statistical difference with that of fish fed the FM diet ($P>0.05$).

The use of probiotics in feed for the sustainability of fish production in earthen ponds is recommended [15]. One of the most important probiotics is brewer's yeast (*S. cerevisiae*) and it has been recognized as a potential replacement for fishmeal. Oliva-Teles and Gonçalves (2001) [5] and Ozorio *et al*. (2010) [10] reported that yeast can replace 50% of fishmeal protein in seabass (*Dicentrarchus labrax*) and pacu diets. Korkmaz and Cakirogullari (2011) [11], Ovie and Eze (2014) [7] and Pongpet *et al*. (2016) [4] reported that yeast can replace 30% of fishmeal protein in Koi carp fingerlings, 40.5% in *C. gariepinus* and 45% in Thai panga diets with no negative effects on growth performance. There are also researchers who have used yeast at a lower level e.g; Ozorio *et al*. (2012) [10] reported that yeast can replace 15 % of fishmeal protein in Tilapia diets with no negative effects on growth performance. Mohammadi *et al*. (2015) [21] reported that the best Feed conversion ratio, Specific Growth Rate, Condition Factor and Body Weight Gain values were observed in *S. cerevisiae* at 2% concentration. The result obtained in our study confirms this view and the growth and feed evaluation performances of fish fed with the trial feed (10% yeast) were similar to those of the fish meal group. Even this amount provided significant advantages in terms of feed cost

### 3.3 Costing
The costs of fishmeal and yeast according to dry matter, energy and crude protein contents were calculated as shown in Table 4.

**Table 4:** Cost calculations for fishmeal, yeast and trial feeds

| Ingredient Type | Fishmeal | Yeast |
|---|---|---|
| Cost per tonne (US$) | 1400 | 800 |
| DM (%) | 92 | 92 |
| CP (%) | 65 | 43.8 |
| ME (MJ/kg DM) | 13.15 | 8.56 |
| Cost per Kg DM (cent/kg) | 152 | 86 |
| Protein Cost $ (kg/CP) | 234 | 196 |
| Energy Cost (c/MJ) | 11.56 | 10.04 |

Information about the Dry Matter percentage and Metabolic Energy concentration can be used to calculate the energy cost per unit and thus determine the true dollar value of a feed or raw material. When the price of fishmeal and yeast is evaluated in terms of dry matter, fishmeal is 75% more expensive than yeast, although the dry matter content of both raw materials is 92% (Table 4). Although fishmeal contains 45% more protein than yeast, there is only a 20% difference between fishmeal and yeast in terms of cost per protein. In the same way fishmeal provides 55% more energy value than yeast. When the cost of metabolic energy was calculated, fishmeal was found to be only 0.3% more expensive than yeast.

The cost of trial feeds was calculated according to raw material usage rates of rations. Prices of raw materials and additives used in feeds were provided by suppliers (Table 5).

**Table 5:** The cost of trial feeds

| Feed Type | FM | Y |
|---|---|---|
| Cost per kg (US$) | 1.178 | 1.118 |
| DM % | 81.46 | 81.56 |
| CP% | 41.53 | 40 |
| ME (MJ/kg DM) | 14.27 | 13.81 |
| Cost per Kg DM (cent/kg) | 144.61 | 137.07 |
| Protein Cost (US$: kg/CP) | 346.74 | 342.67 |
| Energy Cost (c/MJ) | 10.09 | 9.92 |
| Economic feed conversion rate | 1.33 | 1.28 |
| Total trial feed cost (US$) | 7.830 | 6.985 |

The test diets were isonitrogenic and isoenergetic, so the DE, CP and ME values were equal. However, when the total costs of the trial feeds are considered, the yeast feed yielded a cost-saving of 0.06 c / per kg. At the end of the study, the total feed cost of the FM group was $7.830, while that of the yeast group was $6.986. The yeast group had similar growth and development rate to the fish meal group with feed that was $0.846 cheaper.

## 4. Conclusion

European seabass reaches commercial size (300–400 g) in about 24 to 36 months. Even the lowest cost-saving to be obtained from the feeds to be used during this period will have a great effect on the operating cost. Ertekin (2011) [22] found that 81.16% of the total operating cost in the soil ponds and 87.38% of the cage production were variable costs. It has been determined that 49.9% of variable costs in soil ponds and 55.72% of cage establishments were feed costs. In this respect, it is important to work towards reducing feed cost. Work on alternate protein sources such as yeast in earthen ponds should continue. In addition, the use of yeast feeds will be an important contribution to the feed sector in terms of ensuring sustainable production of fishmeal and protecting the environment.

## 5. References


1. Ammar AA. Effect of extruded and trash fish diets on growth performance and pond productivity of sea bream, *Sparus aurata*, the sea bass, *Dicentrarchus labrax* and the flat head grey mullet, *Mugil cephalus* reared in polyculture system in earthen ponds. Egyptian Journal of Aquatic Biology and Fisheries. 2008; 12:43-5
2. Yuan XY, Liu WB, Liang C, Sun CX, Xue YF, Wan ZD, *et al*. Effects of partial replacement of fish meal by yeast hydrolysate on complement system and stress resistance in juvenile Jian carp (*Cyprinus carpio* var. Jian). Fish & Shellfish Immunology. 2017; 67:312-321
3. Byrne J. Stable fishmeal prices forecast, alternative protein players could face choppy waters. https://www.feednavigator.com/Article/2017/05/12/Stable-fishmeal-prices-forecast-alternative-protein-players-could-face-choppy-waters.(11 may 2017_last updated on 26 may 2017).
4. Pongpet J, Ponchunchoovong S, Payooha K. Partial replacement of fishmeal by brewer's yeast (*Saccharomyces cerevisiae*) in the diets of Thai Panga (*Pangasianodon hypophthalmus* × *Pangasius bocourti*) Aquaculture nutrition. 2016; 22(3):575-585
5. Oliva-Teles A, Goncalves P. Partial replacement of fishmeal by brewer's yeast (*Saccharomyces cerevisiae*) in diets for sea bass (*Dicentrarchus labrax*) juveniles. Aquaculture. 2001; 202:269-278
6. FAO. Aquaculture development and coordination program. fish feed technology. Lecture presented at the FAO/UNDP training course in fish feed technology, Seattle, Washington. 1980, 400. http://www.fao.org/docrep/X5738/X5738EOO.htm
7. Ovie SO, Eze SS. Utilization of *Saccharomyces cerevisiae* in the partial replacement of fishmeal in *Clarias gariepinus* diets. International Journal of Advance Agricultural Research 2014; 2:83-88
8. Kumari J, Sahoo PK. Dietary b-1,3 glucan potentiates innate immunity and disease resistance of Asian catfish, *Clarias batrachus* (L.). Journal of Fish Diseases. 2006; 29:95-101
9. Zerai DB, Fitzsimmons MK, Collier JR, Duff CG. Evaluation of brewer's waste as partial replacement of fish meal protein in Nile tilapia, *Oreochromis niloticus*, diets. Journal of the World Aquaculture Society 2008; 39:556-563
10. Ozório ROA, Turini BGS, Moro G, Oliveira LST, Portz L, Cyrino JEP. Growth, nitrogen gain and indispensable amino acid retention of pacu (*Piaractus mesopotamicus*, Holmberg 1887) fed different brewer's yeast (*Saccharomyces cerevisiae*) levels. Aquaculture. Nutrition. 2010; 16:276-283.
11. Korkmaz AS, Cakirogullari GC. Effects of partial replacement of fish meal by dried baker's yeast (*Saccharomyces cerevisiae*) on growth performance, feed utilization and digestibility in Koi carp (*Cyprinus carpio* L., 1758) fingerlings. Journal of Animal and Veterinary Advances. 2011; 10:346-335
12. FAO. Fisheries and Aquaculture Department, Cultured Aquatic Species Information Programme *Dicentrarchus labrax* (Linnaeus, 1758), 2017 http://www.fao.org/fishery/culturedspecies/Dicentrarchus_labrax/en
13. Giannetto D, Acar U, Demir O, Turker A. Current Status and Future Prospective for Aquaculture Sector in Turkey. Austin Journal of Aquaculture and Marine Biology. 2014; 1(1):3
14. Oca J, Reig L, Flos R. Is land-based sea bream production a feasible activity on the northwest mediterranean coast? Analysis of production costs. Aquaculture International. 2002; 10:29-41.
15. Tezel R, Gullu K. A Study on providing sustainability of earthen pond aquaculture facilities producing marine Fish. Journal of Aquaculture Engineering and Fisheries Research. 2017; 3(3):128-140
16. Serpa, D., Falcao, M., Pousao-Ferreira, P., Vi-cente, M. & Carvalho, S. Geochemical changes in white seabream (*Diplodus sargus*) earth ponds during a production cycle. Aquaculture Research, 2007, 38, 1619-1626.
17. Li, P., Gatlin D. M. Evaluation of brewer's yeast (*Saccharomyces cerevisiae*) as a feed supplement for hybrid striped bass (*Morone chrysops* × *M. saxatilis*), Aquaculture, 2003,Volume 219, Issues 1–4,Pages 681-692,
18. AOAC. Association of official analytical chemists. In Official methods of analysis chemists (17th ed.). 2000, Washington, DC. USA.
19. NSW DPI. Buying feed on a feed value basis. 2017. https://www.dpi.nsw.gov.au/animals-and-livestock/nutrition/costs-and-nutritive-value/price
20. Baki, B., Yücel, S. Feed cost/productıon income analysis of seabass (*Dicentrarchus labrax*) aquaculture.

International Journal of Ecosystems and Ecology Sciences (IJEES). 2017; 7(4):859-864

21. Mohammadi F, Mousavi SM, Ahmadmoradi E, Zakeri M, Jahedi A. Effects of *Saccharomyces cerevisiae* on survival rate and growth performance of Convict Cichlid (*Amatitlania nigrofasciata*). Iranian Journal of Veterinary Research, 2015; 16(1):50, 59-62
22. Ertekin H. Comparative Economic Analysis Sea Bass (*Dicentrarchus labrax*) İn Earthen Ponds and Sea Cages The Graduate School of Natural And Applied Science Of Selçuk University The Degree of Master of Science / Agricultural Economics, Konya, 2011. http://acikerisim.selcuk.edu.tr:8080/xmlui/bitstream/handle/123456789/2219/283475.pdf?sequence=1&isAllowed=y.