Determination of Hatching Performances and Yolk Sac Absorptions in Black Sea Trout (*Salmo trutta labrax* Pallas, 1811)

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**Abstract**

The goal of this study was to evaluate hatching performance, body and yolk weight at hatching, the growth rate and yolk conversion efficiency during the yolk absorption in Black Sea trout (*Salmo trutta labrax*, Pallas 1811) larvae. In addition, the relationships between length, total wet weight, dry yolk body weights of alevins and degree-days were determined in this study. Our results indicated that the mean dry weights of the body and yolk sac were 2.85 ± 0.87 g and 23.92 ± 1.04 mg at hatching and 14.95 ± 1.45 g and 1.04 ± 0.90 mg at swim-up stages while the mean wet weight was 17.17 ± 1.67 mg (n = 30) at hatching and reached 104.16 ± 8.18 mg just before the swim-up stage, respectively. The mean dry body matter and water content of the larvae were 46.98% and 53.02% at hatching and 49.03% and 65.16% at swim-up stages, respectively. The growth of larva, yolk sac absorption and yolk conversion efficiency were calculated as 0.49 mg/day. 0.99 mg/day and 0.53, respectively. Data here reported also demonstrated that dry yolk and total larval weights and dry matter of the larvae decreased while dry body weight and water content increased with degree-days. In conclusion, the data will provide benefits for production of Black Sea trout.

**Keywords:** Black sea trout; *Salmo trutta labrax*; Hatching performances; Yolk conversion efficiency; Growth

**Introduction**

The Black Sea trout (*Salmo trutta labrax*) is an endemic species of the Eastern Black Sea coast and rivers and also a new species for aquaculture [1]. Recently, *S. t. labrax* were described by Turan et al. [2] as *S. coruhensis* [3,4]. On-going debate notwithstanding, *S. t. labrax* is one of five ecotypes within Turkey. However, it has been cultured on a commercial scale in the North America, Europe and Eastern Black Sea region of Turkey in trout farms [5].

The first feeding activities from the outside start at swim-up stage of the larvae. In addition, there is a vestige of yolk at the swimming up stage. The first external feeding in hatcheries starts when over 30% percent larvae reached to swim-up stage. Development and transition stages in fish are important due to sensibility to pathogens, diseases, fasting and environmental factors. Despite all, increase in survival and growth rates could be provided through applicable hatchery management at critical stages [5,6].

Most studies to date have focused on larval development of salmonid species, namely, sea trout [7], brown trout [8,9], Atlantic salmon [10,11], rainbow trout [6,12], brook trout [8,13], brook trout and Arctic char and their hybrids [14]. On the other hand, there are a few studies about hatching and yolk sac absorption on the Black Sea trout and their hybrids [6,15,16].

The purposes of the present study were to investigate hatching performance, body and yolk weight, the yolk absorption and yolk conversion efficiency of Black Sea trout (*S. t. labrax*). In addition, the specific objective was to assess the correlations between these different parameters.

**Material and Methods**

*S. t. labrax* (73 females and 30 males) was obtained from the trout hatchery in the Faculty of Marine Sciences, Karadeniz Technical University (Trabzon, Turkey). The sperm and egg were collected by a gentle abdominal massage. The eggs were incubated in a vertical incubator in triplicate using temperature-controlled. After hatching, about 3000 larvae were randomly divided into triplicate batches. Aerated water in the batches was recirculated and 20% of the water was replaced daily. Temperature was recorded two times a day (8:00-9:00, 16:00-17:00). Monitoring of the eggs and alevins was made. In the eyed-egg stage, the eyes were evidently visible as black spots. In the swim-up stage, 50% of the alevins were started to feed and vigorously swimming up in order to food intake. The dead eggs and larvae were removed and counted each day. Ten larvae were randomly sampled at each sampling period (11 times) at 3 or 4 day intervals from the 133th degree-day (ΣT: sum of daily mean temperatures) when 50% of the larvae had hatched i.e. a total of 110 larvae were used during the study at each cross-types. Thus, larvae were sampled at the 228, 257, 287, 316, 346, 375, 405, 435, 465, and 495 degree-days. Larvae were anesthetized with a benzocaine solution (30mg/l) and fixed in 10% formaldehyde. After a minimum three-week interval, preserved larvae were dissected to separate the yolk sac. Body and yolk were dried at 60°C for 48 h and weighed individually after 48 h [7]. Yolk sac efficiency was calculated as YCE = (Lt - L0)/(Y0 - Yt) as per Hodson and Blunt [12], where L is...
The yolk size is affected by different factors such as incubation temperature and period, egg and larva size, and the nutrition and livestock of brood fish and it also varies from species to species. In addition, amount of yolk at hatching affects to larva size. On the other hand, there is no consensus on the relationship between the size of larva and amount of yolk. Dumas et al. [14] reported that the yolk weight was 12.26mg for brook charr (S. fontinalis). In contrast, Hodson and Blunt [12] stated that this value was 31 mg for rainbow trout. In this study, the dry yolk weight at hatching was determined as 23.92 ± 1.04 mg for Black Sea trout larvae.

As documented in previous studies, a decrease in dry matter was at hatching and before swim up stage for Atlantic salmon, rainbow trout [6,10,12]. In this study, the dry body weights at hatching and before swim up stage were determined as 2.85 ± 0.87 (46.98% of total wet weight) and 14.95 ± 1.45 (14.84% of total wet weight), respectively. The present results agree with these reports. The decrease may be explained by increasing the water content of the body towards the swim-up stage for ease buoyancy.

The values of YCE vary between 0.4 and 0.8 [12]. The values for Salmo species are ranged from 0.41 to 0.70 at 10°C. Dumas et al. [14] and Başçınar et al. [13] determined that the YCE value was 0.65 for brook trout at 8-13 °C and 0.50 for brook trout at 4.5-13°C. Başçınar et al. [5] stated that the YCE values were 0.76, 0.41 and 0.46 for Black sea trout, brook trout and their hybrids, respectively. Hansen [7] reported values ranging from 0.46 to 0.68 at 7-8.5°C for S. trutta. In our study, the YCE was 0.53 on a dry weight basis.

As reported in previous studies, development index value was “2” approximately when alevins were a maximum weight [11,18] and development index values increased with increasing water temperature [19]. KD values determined due to importance for the first feeding [6]. Başçınar et al. [16] determined that development index values in alevins were 1.98 and 1.99 at 5°C and 9°C in S. t. labrax. In present study, development index was calculated as 2.11 and the present result agree with the data.

**Conclusion**

In conclusion, based on the data obtained within the context of this study, dry yolk and total larval weights and dry matter of the larvae decreased. Additionally, dry body weight and water content increased with degree-days. These results might be helpful for further comparative studies and in developing efficient hatchery management programs. In addition, information on yolk sac absorption and hatching performance of this species would contribute to knowledge of management of the stocks.

**Table 1:** Duration (day) of eyed-egg, hatch and swim-up phases.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Eyed-egg stages</th>
<th>Hatching</th>
<th>Swim-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>25</td>
<td>39</td>
<td>62</td>
</tr>
<tr>
<td>D-D</td>
<td>233±2.3 (193-263)</td>
<td>366±2.7 (315-401)</td>
<td>595±43 (477-651)</td>
</tr>
<tr>
<td>°C</td>
<td>9.3±0.9 (7.7-10.5)</td>
<td>9.4±0.9 (8.1-10.3)</td>
<td>9.6±0.7 (7.7-10.5)</td>
</tr>
</tbody>
</table>

**Figure 1:** Gains in (a) length and (b) wet weight of Black sea trout larvae raised in freshwater.

**Figure 2:** Relationship between degree-day and (a) yolk-sac weight and dry larvae weight (b) in Black sea trout alevins.

The yolk size is affected by different factors such as incubation temperature and period, egg and larva size, and the nutrition and livestock of brood fish and it also varies from species to species. In addition, amount of yolk at hatching affects to larva size. On the other hand, there is no consensus on the relationship between the size of larva and amount of yolk. Dumas et al. [14] reported that the yolk weight was 12.26mg for brook charr (S. fontinalis). In contrast, Hodson and Blunt [12] stated that this value was 31 mg for rainbow trout. In this study, the dry yolk weight at hatching was determined as 23.92 ± 1.04 mg for Black Sea trout larvae.

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Table 2: Summary of some characteristics reported from trout and comparisons with the present study results.

<table>
<thead>
<tr>
<th>Species</th>
<th>Eyed-egg stages (days)</th>
<th>Hatching (days)</th>
<th>Dry yolk weight (mg)</th>
<th>YCE</th>
<th>Development index</th>
<th>Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmo salar</td>
<td>12.26</td>
<td>0.65</td>
<td>Dumas et al. [14]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvelinus fontinalis</td>
<td>0.5</td>
<td>1.98-1.99</td>
<td>Başçınar et al. [13]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. t. labrax</td>
<td>17-24</td>
<td>35-41</td>
<td>0.41-0.76</td>
<td>Başçınar et al. [16]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. t. macrostigma</td>
<td>25</td>
<td>53</td>
<td>20.9</td>
<td>Alp et al. [17]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. abanticus</td>
<td>27</td>
<td>54</td>
<td>18.47</td>
<td>6.4</td>
<td>2.09</td>
<td>Kocabas et al. [18]</td>
</tr>
<tr>
<td>S. t. caspius</td>
<td>26</td>
<td>44</td>
<td>10.67</td>
<td>0.6</td>
<td>2.05</td>
<td>Kocabas et al. [18]</td>
</tr>
<tr>
<td>S. t. labrax</td>
<td>25</td>
<td>39</td>
<td>23.92</td>
<td>0.53</td>
<td>2.11</td>
<td>In this study</td>
</tr>
</tbody>
</table>

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References