Short Paper

Changes of serum growth hormone and vitellogenin levels during vitellogenesis in female masu salmon

Oncorhynchus masou

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KEY WORDS: growth hormone, masu salmon, vitellogenesis, vitellogenin.

Growth hormone (GH) not only promotes somatic growth,1 but also regulates sexual maturation in teleosts.2-4 In immature rainbow trout Oncorhynchus mykiss, administration of recombinant GH resulted in elevated circulating estradiol-17β (E2) levels in vivo.2 In ovarian culture experiments of goldfish Carassius auratus and spotted seatrout Cynoscion nebulosus, recombinant GH in combination with gonadotropic hormone (GtH) accelerated the synthesis of E2.3,4 Vitellogenin (Vg), a precursor of egg yolk proteins, is produced in the liver in response to circulating E2, released into the bloodstream, taken up by developing oocytes, and chemically modified in the process of yolk formation.5 It has been suggested that GH is involved in vitellogenesis via estrogen production. However, there are only a few reports on changes of serum GH levels during vitellogenesis.6-9 This study aimed to compare the profile of serum GH with those of Vg and gonadosomatic index (GSI) in female masu salmon during vitellogenesis.

Masu salmon were obtained in 1994 (0-year-old) to 1995 (1-year-old) from captive broodstocks (n=100) reared in freshwater outdoor ponds at the Nanae Fish Culture Experimental Station, Faculty of Fisheries, Hokkaido University, Japan. This strain of masu salmon spawns in September in 1 year olds. Sampling of masu salmon was carried out between 13:30 and 14:30 h. The GSI was calculated as follows; GSI (%) = (gonad weight/body weight) × 100. Blood samples were taken with a syringe from the caudal vessels of each fish. Serum was separated by centrifugation at 13,000 × g for 10 min and stored at –30°C until use. Serum Vg concentration was measured by single radial immunodiffusion according to the method of Hiramatsu et al.10 Serum GH levels were measured using the enzyme-linked immunosorbent assay (ELISA) reported previously.11 Serum E2 levels were measured by an estradiol EIA kit (Cayman Chemical Company, Ann Arbor, MI, USA). All assays were carried out in duplicate. Results are presented as mean ± SEM. Data were analyzed by one-way analysis of variance (ANOVA) and Fisher’s protected least significant difference (except for April and the E2 data). Probability of P<0.05 was considered as the significance level.

Figure 1a shows the change in body weight (BW) of female masu salmon. The weights increased gradually from December to May, and then dramatically rose in May. The BW increased from 311.5 ± 33.5 g to 566.2 ± 36.6 g. From June to September, BW was relatively constant. The changes in GSI are shown in Fig.1b. The GSI was very low in December, and increased only slightly through June. The GSI increased significantly during June and reached a peak in September (23.2 ± 1.1%). All female fish ovulated in September. Changes of serum E2 and Vg levels are shown in Fig. 2a. Serum concentrations of E2 increased from April (4.5 ng/mL), peaked in August (18.3 ± 0.7 ng/mL), and decreased in September (6.2 ± 2.0 ng/mL). The Vg in female serum was first detected in February. Serum Vg levels increased significantly during May, and then reached a peak (15.0 ± 1.6 mg/mL) in August. The Vg levels then decreased dramatically to about 0.1 mg/mL in September, near the time of ovulation. Figure 2b shows the changes in serum GH levels. Serum GH levels were maintained around 30 ng/mL from December to April. In May, approximately 4 months prior to spawning, serum GH levels increased significantly and reached peak levels (59.5 ± 2.5 ng/mL). In June, levels of GH declined and were maintained at relatively constant levels from July to September.

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Received 20 September 1999. Accepted 23 February 2000.
We observed a large peak in serum GH levels in May in female masu salmon. The doubling of serum GH levels was followed by a large growth spurt and increasing GSI. Furthermore, the GH peak was followed by an elevation of E2 and Vg levels. Although these data are just correlative, GH may enhance reproductive maturation in masu salmon; GH is known to have steroidogenic effects.2–4 The GH stimulated the in vitro production of testosterone in testis and E2 in ovary.12 In mammals, it has been shown that steroidogenesis is stimulated by an insulin-like growth factor-I (IGF-I) which was produced in the liver under the influence of GH.13 The IGF-I has been identified in teleosts.14 We speculate that a GH surge may have stimulated IGF-1 which in turn stimulated E2 production in female masu salmon. Further investigation is necessary to confirm this hypothesis.

We thank Prof. Walton W. Dickoff for critically reading the manuscript. Thanks are also due to Mr Shizuo Kimura for maintenance of the fish and Mr Norimasa Ichikawa and Miss Kaori Hosokawa for technical assistance during this study. This research was supported by a Grand-in-Aid for Scientific Research from the Japanese Ministry of Education, Science and Culture.


