BIOTECHNOLOGY AND THE INDUCTION OF FINFISH-SPAWNING

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The successful development and intensification of finfish aquaculture requires a reliable and predictable supply of eggs and juveniles. However, most commercially important marine fish either do not spawn, or spawn in an unpredictable manner when raised in captivity. This paper reviews our research and development efforts that led to the development of hormonal-based technologies to induce spawning in farmed fish. Directions for future research are also considered.

We have demonstrated that the lack of final oocyte maturation (FOM), ovulation and spawning in a number of captivity-held farmed fish is the result of a failure of the females pituitary to release the maturational gonadotropin (GtH-II) to the blood circulation (1 for review). Injection of the native hypothalamic gonadotropin-releasing hormone (GnRH) induces a brief surge of GtH-II secretion from the pituitary, but not ovulation or spawning. This is due to the rapid degradation of the native GnRHs by specific enzymes located in the pituitary, liver and kidney (2). GnRH analogs (GnRHa) have been designed, that are highly resistant to enzymatic degradation (3), possess high affinity to the pituitary GnRH receptor and are thus super-potent in inducing GtH-II secretion (4 for review). However, these GnRHa still disappear relatively fast from the fish circulation. Multiple injections of these GnRHa are required to successfully induce ovulation and spawning in farmed fish, which is stressful to the fish, results in mortalities and is labor intensive. We have therefore incorporated the superactive GnRHa into polymer-based controlled-release delivery systems that, once administered to the fish, release the GnRHa in a sustained manner for prolonged periods of time (4). These GnRHa delivery systems have been optimized and tested for a variety of farmed fish, and were shown to be highly efficient in inducing successful spawning in multiple species, including gilthead seabream, seabass, grouper, turbot, striped bass, white bass and a number of trout and salmon species. The controlled-release GnRHa devices are also potent enhancers of spermiation.

The above technology has been developed using analogs of mammalian or salmon GnRH. However, recently we have shown that the brain of evolved perciform fish, including seabream and striped bass, contains three forms of GnRH: chicken GnRH-II, salmon GnRH and a novel form of GnRH named seabream (sb) GnRH (5, 6). Based on its localization in the hypothalamus and its abundance in the pituitary of spawning fish, sbGnRH is believed to be the endogenous GtH-II releaser and thus most relevant to FOM, ovulation and spawning in seabream and striped bass. Analogs of sbGnRH are presently being synthesized and evaluated for their potency to induce GtH-II secretion and spawning, for identification of the most potent analogs of the physiologically relevant GnRH form, to be used for spawning manipulations.

It is clear that the failure of farmed fish to spawn spontaneously in captivity is the result of a disruption in the GnRH system. In order to better understand the nature of the problem, we have cloned and characterized the cDNAs encoding the three GnRH forms present in seabream and striped bass brains (7, 8). The brain distribution of the three GnRHs has been described using *in situ* detection of their specific mRNAs. Only sbGnRH was found to be expressed in the preoptic area of the brain, which is known to control gonadotropin secretion. We have also cloned and sequenced the gene encoding sbGnRH. Using all these tools, the regulation of the expression of the GnRH genes by environmental and neuroendocrine factors will be studied.

These studies are expected to lead to a new approach for the control of fish reproduction in aquaculture, based on the manipulation of GnRH biosynthesis at the level of its gene.

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