

Induction of Sex reversal in fishes (rationality - masculinization – feminization - applications)

Introduction: Sex reversal in fishes may occur in nature under specific environmental or social conditions. It has been reported that male fish living in water contaminated with female hormones such as estrogen can become feminized and develop female sex characteristics as well as behaviors. In some fish communities, a social group consists of a dominant male with 3-6 females. If for whatever reason, the male is absent (e.g. fished or died); shortly after one of the females turns into male. This phenomenon has been reported in a coral reef fish species, *Labroides dimidiatus*. It has been claimed that the existence of anti-androgens in the effluents in wastewater treatment has caused sexual disruption in fish living in English rivers.

Rationality: As expected, sex reversal –if applied- in fish must have reasons whether biological or economical. Therefore the direction of sex reversal varies either towards males (masculinization) or females (feminization).

In aquaculture, higher growth rate of farmed fish is always targeted. Thus, in fish such as tilapias, whereas fish exhibit positive sexual dimorphism in regard to the growth rate of male, the efforts has been directed to producing all-male tilapia.

Added to that, in fish species which reach sexual maturation at younger age and smaller size such as tilapia, growth rate would be of particular importance to ensure that fish reaches marketable size before reaching sexual maturation. When this is linked to sexual dimorphism, all-male tilapia will be the scenario to adopt in case of tilapia.

On the other hand, different scenarios have been practiced to produce mono-sex female of rainbow trout to meet the demand in consumer market.

Applications: The technology adopted for sex reversal depends on several factors such as sex determining mechanism in target species, effectiveness of the practice, legality and public concerns. It was discovered decades ago that regardless of genetic sex, the balance between androgens (male hormone) and estrogens (female hormone) may determine which gonadal sex develops. If exogenous hormones are used in the sex reversal, the administration of hormones has to be during the gonadal differentiation of target species.

The period of gonadal differentiation varies significantly among species categories. In general, this period is much shorter in warm water fishes compared to cold water fishes. For example, this period has been found to be about 20 days in tilapia, this is why the hormonal sex reversal of tilapia fry usually lasts for at least 22 days starting from the first feeding tilapia fry. On the other hand, the period of gonadal differentiation in cold water fish lasts much longer time. The hormonal treatment for sex reversal begins following the beginning of exogenous feeding. In order to achieve successful results, steroid hormones should be administered consistently during the whole process of sex determination.

The most used masculinization hormone is 17 α -methyltestosterone or 11-hydroxyandrostenedione. However, Methyltestosterone is the most commonly used synthetic androgen to alter the sex ratio of fish; its effectiveness is based on the proper hormone dose for enough duration as well as when used on the proper age of treated fry. In other words, the intervention using exogenous steroids at the early stage in the life history targets to override the sex expression of genotypically determined sex.

In regard to feminization, there has been growing demand in recent years for the culture of mono-sex female of rainbow trout for the consumer market. All-females of rainbow trout could be produced

through either “gynogenesis” or the administration of estrogen hormone (estradiol-17 β). Females may be preferred if the roe is commercially important. Males may be desired in ornamental fish for their coloration.

Synthetic androgens have been found more effective over natural ones. When natural androgens have been evaluated, the effectiveness on the sex reversal process came variable and not reliable.

The hormones –if used- to induce sex reversal, it can be administered in feed or used through the immersions for some time during a particular period.

It worth mentioning, the use of hormones in food production (e.g. sex reversal) is generally forbidden in many countries.

Application in ornamental fish: Many species of ornamental fish exhibit sexual dimorphism as reflected in size, coloration and pigmentation. Therefore, and based on the market demand, the production of all-male or all-female stocks of ornamental fish is targeted.