

Application of Synthetic Hormones in Fish Production

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ABSTRACT

Fish are considered as a good source of protein, polyunsaturated fatty acids, vitamins, minerals which supports overall health. Owing to its health benefits along with population expansion, demand for fish is steadily increasing. This has led to significant rise in fish farming or aquaculture to meet the growing demand. Currently aquaculture has surpassed capture fisheries in global fish production. In fish production, exogenous hormones are commonly used either for induced breeding to produce seeds or for sex reversal to produce monosex population that exhibits a higher growth rate. These hormones may be natural origin or synthetic in nature. The article discusses the synthetic hormones that are commonly employed in fish production and have become indispensable for aquaculture.

INTRODUCTION

Fish serves as a significant source of high-quality protein, essential fatty acids, vitamins, and minerals, which are crucial for sustaining overall health, facilitating growth and development (Noreen *et al.* 2025). Fish protein is readily digestible due to presence of low connective tissue and are rich in bioactive peptides and essential amino acids (Sathivel *et al.*, 2004). Fish are

excellent source of polyunsaturated fatty acids such as eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) that support brain development and cardiovascular health (Abraha *et al.*, 2018). Additionally, fish are a source of vitamins and minerals that are important for various body functions, including their antioxidant effects, the regulation of metabolism, and the processes of

growth and development (Ali *et al.*, 2022). Owing to its health benefits in addition to being an excellent source of protein, the worldwide demand for fish has been consistently rising. This has led to a significant increase in fish farming to satisfy the rising demand for fish, which is driven by health consciousness and population expansion.

As per the report from Food and Agriculture Organization (FAO), aquaculture has surpassed capture fisheries in production of fish and is further increasing (FAO, 2024). One of the key factors for the domestication and creation of a sustainable aquaculture industry is the ability to control the reproductive processes of fish held in captivity, in addition to securing high-quality seed for the production of marketable product. Reproduction of fish in captivity can be controlled by environmental manipulations but exogenous hormones are used as an effective way for breeding of fish in captivity (Mylonas *et al.*, 2010). Likewise, hormones are also used for sex reversal, promotion of growth, production of mono-sex population in fish (Islam *et al.*, 2024). This article discusses about various synthetic hormones having major role in aquaculture and their future perspectives.

Synthetic Hormones Used in Fish Production

- Sex reversal and growth regulation - In aquaculture, hormonal treatment is applied for sex reversal to generate monosex populations that exhibit improved growth and weight gain. Hormonal treatment promotes enhanced growth and improved flesh quality by redirecting nutrients that would otherwise be allocated to gonadal development. Fish subjected to hormonal treatment exhibited increases in growth parameters, muscle composition, feed efficiency, and overall lipid profile. For example, hormone treated fish particularly

the cichlids and cyprinids for sex reversal may grow up to three times faster than the untreated ones. Sex reversal is done to produce the more profitable gender to get uniform sex with higher growth rate and also to control undesirable breeding. Synthetic 17α -methyltestosterone is commonly employed for masculinization, whereas natural 17β -estradiol is generally preferred for feminization. 17α -methyl testosterone has been commonly used in tilapia to reverse females into males. Sex reversal in fish can be induced through hormonal treatment during sex differentiation. Hormones may be administered via systemic methods, immersion techniques, or through incorporation in feed. In practice, immersion and feeding methods are most commonly used as they can be applied to large groups of fish, whereas systemic administration is costly and demands considerable technical expertise. In immersion treatments, the effectiveness of the hormone depends not only on its dosage but also the type, water temperature, and duration of exposure. Comparatively, incorporating hormones into feed is more efficient, as it offers precise control and ensures an optimal dose to achieve complete sex reversal in all individuals (Pandian and Sheela, 1995; Hoga *et al.*, 2018).

- Artificial reproduction - Another use of hormones in aquaculture is in induced breeding for seed production by manipulating the final maturation of gonad and ovulation. Exogenous hormones can be used to stimulate gonadal maturation, enabling fish to spawn outside their natural breeding season, thereby ensuring a constant supply of seed for farming. The use of exogenous hormones is particularly necessary to induce spawning in species that fail to reproduce naturally under

captive conditions. Hormonal manipulation serves as an effective management tool to improve egg production, enhance spermiation, and facilitate hatchery practices. The hormones are applied through intramuscular or intraperitoneal injection in broodstocks. Analogs of Salmon Gonadotropin-Releasing Hormone (sGnRH) is one of the most widely used synthetic hormones for inducing maturation and spawning across various fish species. Its application is often combined with dopamine antagonists to suppress dopamine's inhibitory action, thereby enhancing the effectiveness of GnRH treatment (Hoga *et al.*, 2018). Some of the commercially available formulation containing sGnRH alongwith dopamine inhibitor are Ovaprim, Ovatide, Spawnpro, Ovafish, and WovaFH.

Future perspectives

Synthetic hormones will likely continue to contribute in fish production as it has significantly enhanced fish breeding, sex reversal, growth promotion, and overall productivity. However, growing concerns about environmental safety, consumer health, and sustainability demand a re-evaluation of their long-term role in fish farming. This may lead to a gradual shift towards more targeted, eco-friendly and integrated approaches. The advancement in biotechnology and molecular biology may enable to design next-generation synthetic hormones with higher specificity, lower effective doses, and reduced persistence in the aquatic environment. Instead of long-term hormone treatments, precise genome editing may be adopted to induce permanent changes in sex differentiation or growth traits, reducing dependence on synthetic chemicals provided the new techniques are economically viable. Future research may focus on plant-derived phytohormones, probiotics, immunostimulants, and environmental manipulations (temperature, photoperiod

control) as sustainable alternatives. Strict regulations on the use of steroid hormones and consumer preferences of healthier product may contribute toward minimizing its use leading to increase attraction towards development of better and safer alternatives.

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