Sem 6th

Unit III Topic 5

**Transgenic Fishes: Meaning, Development and Application**

***In this article we will discuss about:-***

1. Meaning of Transgenic Fish

2. Development of Transgenic Fishes

 3. Controlled Culture of Transgenic Fish and Feed

4. Gene Transfer Technology for Development

 5. Applications

6. Environmental Concerns

7. Transgenic Fish could Threaten Wild Populations

8. Transgenic Fish Invasive Species.

***Meaning of Transgenic Fish:***

A transgenic fish is one that contains genes from another species. A transgenic fish is an improved variety of fish provided with one or more desirable foreign gene for the purpose of enhancing fish quality, growth, resistance and productivity.

Typically, genes of one or more donor-species are isolated, and spliced into artificially constructed infectious agents, which act as vectors to carry the genes into the cells of recipient species. Once inside a cell, the vector carrying the genes will insert into the cell’s genome.

A transgenic organism is regenerated from each transformed cell (or egg, in the case of animals), which has taken up the foreign genes. And from that organism, a transgenic variety can be bred. In this way, genes can be transferred between distant species, which would never interbreed in nature.

The application of genetic engineering to animals, like potatoes with built-in insecticide, could provide numerous benefits, including the possibility of a safer, cheaper food supply and the creation of new sources for inadequate pharmaceutical resources.

With the advancement in the field of genetic engineering, the application of its commercial use has also increased. Aquatic animals are being engineered to increase aquaculture production.

The use of genetic engineering and rDNA technology has done miracles in medical and industrial research. The transgenic fish are being promoted as the first marketable transgenic animals for human consumption.

One of the most important aspects between fish and other terrestrial animals for cultivation and genetic improvement is that, usually, fishes have higher levels of genetic variation and hence more scopes for selection than most mammals or birds.

Using the gene transfer technology, scientists now have created a genetically engineered variety of Atlantic salmon that grow to market size in about 18 months, otherwise the fish takes about 24-30 months for becoming market size fish. It is also hoped that we can now modify a large number of fishes with fast growing characteristics and bring Blue Revolution.

The following are the important points needed for genetic engineering (gene transfer) to produce transgenic fish:

(1) A gene sequence is to isolate for the particular characteristics; for example, growth hormone gene.

(2) These genes (gene sequence) are then inserted into a circular DNA known as plasmid Vector (enzymes endonucleases and ligases are used).

(3) Plasmids are harvested in the bacteria to produced billions of copies.

(4) Plasmids are introduced into linear DNA. The linear DNA is sometimes called a gene cassette because it contains several sets of genetic material in addition to new inserted gene; for example, growth hormone gene. The technology is available to integrate genes in germ line of developing individual (fish) and finally transmitted into further generations.

(5) Making the cassette a permanent part of fish’s genetic makeup.

**Development of Transgenic Fish**

Development of transgenic fish has focused on a few species including salmon, trout, carp, tilapia and a few others. Salmon and trout are cash crops while the others primarily provide sources of protein. Currently, about 40 or 50 labs around the world are working on the development of transgenic fish.

About a dozen of them are in the U.S., another dozen in China, and the rest in Canada, Australia, New Zealand, Israel, Brazil, Cuba, Japan, Singapore, Malaysia, and several other countries. Some of these labs are associated with companies that expect to commercialize their fish in a few more years.

Many of the fish under development are being modified to grow faster than their wild or traditionally bred aquaculture siblings.

Faster growth is usually accomplished by transferring a fish growth hormone gene from one species of fish into another. The faster growing fish not only reach market size in a shorter time, they also feed more efficiently. Trout growth hormone (GH) was used to produce transgenic carp with improved dressing properties. Such transgenic carp are recommended for production in earthen ponds.

***Transgenic Salmon:***

The Atlantic salmon is engineered with a pacific salmon, growth hormone driven by the arctic antifreeze promoter gene. The rapid growth of that transgenic salmon is achieved, not so much by the transgenic growth hormone as by the antifreeze gene promoter that functions in the cool water desirable for salmon flavour.

Devlin (1994) research scientists with Fisheries & Oceans, Canada, in West Vancouver, British Columbia has modified the growth hormone gene in Coho salmon by developing a gene construct in which all the genetic elements are derived from sockeye salmon.

The transgenic Coho grew on average 11 times faster than unmodified fish and the largest fish grew 37 times faster. The growth hormone levels in the transgenic fish are high year-round, rather than falling off in the winter as occurs in ordinary salmon. Devlin (2001). The modified salmon are large enough to be marketed after one year, in contrast to standard farmed salmon that do not reach market size for at least three years.

***Transgenic Tilapia:***

Tilapia fish, native to Africa, are cultured world-wide as “poor man’s food”, second only to carp as warm water food fish, and exceeding the production of Atlantic salmon (whose market value is twice that of tilapia). Tilapia has been exten­sively genetically modified and promoted as a transgenic fish exclusive for isolated or contained production.

Transgenic tilapia, which is modified with pig growth-hormone, has three times larger than their non-transgenic siblings. Tilapia genetically modified with human insulin grew faster than non-transgenic siblings, and could also serve as a source of islet cells for transplantation to human subjects.

***Transgenic Medaka Fish:***

Purdue animal scientist Muir and Howard (1999) used tiny Japanese fish, Oryzias latipes called medaka to examine what would happen if male med akas genetically modified with growth hormone from Atlantic salmon. Inserting a gene construct consisting of the human growth hormone driven by the salmon growth promoter into medaka produced the transgenic medaka.

The viability of groups of modified and conventional fish was measured at three days of age, and 30 percent fewer transgenic fish survived to that age. The researchers calculated that large males had a four-fold mating advantage, based on observations of wild-type medaka. In another experiment Silk moth genes were introduced into Medaka fish to create resistance to bacterial pathogens.

***Transgenic Zebra Fish:***

The tiny zebra fish (Bmchydanio rerio) that lives in aquariums, was genetically modified to produce a fluorescent red pigment, and is being promoted for sale as a household aquarium pet, the “goldfish”.

These transgenic zebra fish with vivid fluorescent colours (green, yellow, red or orange) fluorescent proteins can be seen with naked eyes under both daylight and ultraviolet light in dark. The green fluorescent protein (GFP) is originally isolated from the jellyfish (Aequorea tictoria).

***Transgenic common Carp:***

In the common carp the growth hormone DNA from rainbow trout fused to a sequence from an avian sarcoma virus.

The genetic material was injected into fertile carp eggs with microinjection. The offspring of the first generation of transgenic fish grew 20 to 40% faster than their unmodified siblings. Chen is also developing transgenic catfish, tilapia, striped bass, trout, and flounder.

They use microinjection and electroporation to inject another copy of a fish growth hormone gene into fertile fish eggs. The growth of the resulting modified carp and catfish is stimulated by extra fish growth hormone.

In India, research in transgenic fish was initiated in Madurai Kamaraj University (MKU), Centre for Cellular and Molecular Biology (CCMB), Hyderabad and National Matha College, Kollam with borrowed constructs from foreign scientists.

The first Indian transgenic fish was generated in MKU in 1991 using borrowed constructs. Scientist in India has developed experimental transgenic of rohu fish, zebra fish, catfish and singhi fish.

Genes, promoters and vectors of indigenous origin are now available for only two species, namely rohu and singhi for engineering growth. Transgenic rohu recently produced from indigenous construct at Madurai Kamaraj University has proved to be eight times larger than the control siblings. This transgenic rohu attains 46 to 49 grams body weight within 36 weeks of its birth.

***Auto-Transgenesis:***

Indian scientists are concentrating on developing transgenic fish through auto-transgenesis which involves just increasing the copies of growth hormone genes present in a fish as opposed to allotransgenesis which amounts to transfer of genes from different species.

The increase in growth homone genes leads to an increase in flesh content. Indian scientists feel that auto-transgenesis is safer and less controversial the generation time of most fish species is shorter and breeding frequency is relatively higher.

A single female can produce several hundred or thousand eggs and thus provide a larger number of genetically identical eggs. Besides, the most important advantage is that the fertilization is external and can be readily controlled by experimental manipulation ,the limited availability of transgenes of piscine origin had been the major hurdle in production of transgenic fish. However, with advancements in molecular biology, more than. 8500 genes and cDNA sequences of piscine origin have been isolated, characterized and cloned in the world.”



