GMO Fish: Are We Ready?

USFDA has determined that G.M. Atlantic salmon are safe to eat but is considering marked restrictions on farming of the fish. Through product labeling, should informed consumers be allowed to drive demand for the salmon?

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Summary:
The U.S. Food and Drug Administration is determining if genetically modified salmon may be farmed and what restrictions should be in place if they are. Although the diets of North Americans already include genetically modified plants, disparate conclusions are being drawn in scientific literature about the safety and economic viability of G.M. fish. It is clear that developing general guidelines will be problematic. Each genetically modified organism must be examined on its own merits.

The United States Food and Drug Administration (FDA) recently determined that genetically altered Atlantic salmon are safe to eat and that consuming the meat poses no threat to consumers. This decision has been a long time coming, and advocates believe it heralds the beginning of a widespread acceptance of genetically modified animals in the diets of American consumers. The FDA is in the final stages of determining if the fish should be allowed to be farmed and what restrictions should be in place if they are.

Genetic manipulation is nothing new. Whenever farmers select for animals or plants that grow faster, convert better or are more resistant to disease, this is a form of genetic alteration and is the basis of domestication. Few would argue that domestication of animals and plants is a bad thing, although there certainly have been some ecological consequences resulting from the introduction of non-native species.

Genetically Modified Organisms

Genetically modified organisms (GMOs) have had their genetic material altered via biochemical manipulation. The engineering of genetic material has only relatively recently reached the point where manipulation of specific genes that control the amount of a given gene product can be routinely accomplished.

This genetic manipulation has far-reaching consequences in our ability to understand and treat many of the diseases that affect humanity and the animals and plants on which we rely for food. We can now bypass the tedious methods of traditional genetic selection and develop strains that have desired traits that far exceed what we might be able to achieve through traditional genetic selection techniques, ultimately allowing science to better feed Earth's burgeoning population.

Few would suggest that this technology does not offer substantial promise. It is, however, a double-edged sword with some complex ethical issues. Some critics have voiced concerns that when there is commercial interest in selling a plant or an animal that has been genetically modified, biases on the part of the manufacturers set a stage for potential abuse of the scientific method and exaggeration of the product's merits. The criteria for establishing the safety of these altered organisms are still evolving and are the subject of considerable debate.

G.M. Plants

Genetically engineered plants are widely consumed globally. At this time, more than 80% of the corn and Hawaiian papayas, and 90% of the canola, soybeans and sugar beets consumed in the United States have been genetically modified. Although there are different types of changes, the most widespread modification has been the insertion of a bacterial gene that confers resistance to specific herbicides, allowing the herbicide to be used with impunity on these crops and leading theoretically to greater yields.

The diet of the average North American has for some time contained very high levels of genetically modified plants, and it would be difficult for a concerned consumer to avoid them, as they are not labeled as such. An analysis of the literature reveals that disparate conclusions are being drawn about the safety and economic viability of GMOs, with some suggesting the issue is being clouded by biased researchers. There is no solid evidence of any significant negative impact associated with consuming these plants, although epidemiological studies are admittedly

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lacking and work is ongoing.

Pigs, cows, chickens and some fish species – zebra fish, goldfish, carp, silver carp, mud loaches, tilapia, channel catfish and salmonids including rainbow trout – have all been successfully altered by adding genes or modifying the control of existing genes. None has been commercialized except the zebra fish, a tropical species sold for home hobbyists. No animals genetically modified using biochemical techniques are currently sold for human consumption.

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Complex Subject

Genetic modification is a very contentious and complex subject, as it encompasses some very tough questions that must be addressed before widespread dissemination should be allowed. These include, but are not limited to:

1. **What are the potential negative impacts of consuming the meat?** Typically, the area of greatest concern deals with the potential for genetic changes in the composition of the consumable part of the animal that result in properties that might cause more widespread allergic reactions.

   Another important area of concern is the impacts the altered genes will have on consumers eating the fish. Can these gene products cause physiological changes? Are they destroyed by the heat of cooking? Are there indirect effects?

   An oft-cited example is growth hormone. Studies suggest that growth hormone levels are linked to insulin growth factor levels. These, in turn, are linked to certain types of cancer. What, if any, concerns are there when elevated growth hormone levels are present? The evidence to date suggests the risks are minimal, if they exist at all. To be "absolutely sure," more research needs to be done.
2. **If animals were to escape, how would that affect local ecosystems?** Would the genes become established in native populations that might breed with escaped animals, and would these confer some advantage (or disadvantage) that could negatively affect the population? Ecosystems can easily be damaged by the inadvertent (or deliberate) introduction of non-native species.
3. **What are the real advantages?** Are there changes in the nutritional quality of the meat? Typically farmers want faster growth, disease resistance and the ability to gain nutrients from feeds in a manner that allows less-costly feed formulations to be used.

   Advantages can include impacts on direct costs, such as how much feed costs and how much feed it takes to produce the animal. Will a faster-growing animal result in less time from egg to market and indirectly affect costs, or will increased ability to digest plant proteins allow reduced amounts of dietary fish by-products, making the diet potentially more environmentally friendly? The potential is endless.

G.M. Salmon

The animals that are currently under the looking glass are Atlantic salmon that have the ability to produce excess amounts of growth hormone genetically engineered into them. They contain a growth hormone gene from Chinook salmon and a DNA fragment from another fish species, pout, to control production of this hormone. These are transgenic animals in that foreign genes have been introduced. This is the first such animal that has been subjected to this scrutiny.

Growth hormones are a natural component of the growth process in all animals. What has been done is modifying the ability of the fish to regulate hormone production in a manner that ensures higher than normal levels at specific times in the growth cycle, resulting in fish that grow much more quickly than their non-engineered counterparts.

There is no evidence that the levels of growth hormone expressed would be problematic. Growth hormone levels vary between individual fish, and the overall levels noted by workers in the field do not appear to be outside what could occur naturally.

The growth hormone being controlled by altering its genetics is a protein. The many hormones in animals are produced by a variety of tissues. Hormones are how cells communicate with each other. Natural levels of hormones vary in animals, and many are readily destroyed by the heat of cooking.

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While there is no sound scientific basis that consumption of the flesh of these fish would in any manner be harmful to those eating it, legitimate criticisms have been leveled about the manner in which this has been determined. Some would argue the

Consumers already eat genetically modified soybeans, corn and beets. Can the success of these plants transfer to G.M. seafood?

precautionary principle should apply – that until absolute proof, whatever this means, showing the fish are not harmful is provided, they should be assumed harmful. Others would argue there is no logical basis for this to be a concern.

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General Guidelines

It is clear that developing general guidelines will be problematic. Each organism that is genetically modified must be examined on its own merits. An examination of each of the points mentioned earlier is essential for understanding the risks.

Will eating the meat harm you? Studies must support the idea that they do not and validate the claims made through sizable sampling. Additionally, the potential connection of growth hormone to a hormone that regulates insulin production is an area of concern, although the extent to which either of these is a real issue is not clear.

The second issue is what would happen if cultured fish escaped? There is no way to state with 100% certainty that this cannot occur. Even in a tightly secured environment, the potential exists for disgruntled employees to release fish. For fish farmed in estuarine environments, culture cages are susceptible to a variety of natural impacts, including storms, wear and tear, human errors, etc. Fish do sometimes escape. This is a fact of life, although every effort is made to minimize it.

Technologies exit to rear fish in land-based systems where escape is not possible unless it is deliberate. It is also possible to use genetic manipulation early in the growth cycle to produce triploid animals that are typically sterile. Fish can also be hormonally manipulated to produce populations that are largely of a single sex.

Rather than trying to figure out what would happen if fish escaped and mated, it makes more sense to use technology to prevent this from happening. Land-based recirculating systems would ensure this to the greatest extent, but markets would be limited.

Perspectives

The aquaculture industry is technologically capable of producing animals that have genetic compositions that make them ideal for production in aquaculture environments. Improved growth, disease resistance, feed utilization and nutrient content are only the tip of the iceberg. The benefits to a world population that is growing by more than 1% per year are incalculable.

While caution is reasonable in the absence of significant proof of harm or the potential for harm, it seems prudent that consumers should be allowed to make the choice and drive the demand for products of this nature. This is accomplished by labeling products as modified by the use of biochemical genetic manipulation.

Ultimately, consumers will decide if we are ready for this leap in technology. In many areas of the world, the harsh dictates of day-to-day reality favor the advantages of consuming protein produced in this manner over the risks, real and perceived. Their needs will drive the demand, not those of the first-world nations.