ANIMAL BIOTECHNOLOGY:

Advances and Its Applications

[Course name or code]

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**Abstract**

Use of advanced techniques linked to biotechnology can do wonders in the fields of agriculture and zoology. There has been a dramatic increase in biotechnology development especially with genetic engineering. This paper is a compendium of information that covers the fundamentals of technical advances in scientific animal biotechnology sectors which are: animal transgenesis, animal cloning, and genetic engineering of animals. The contents are highly informative and useful and will provide an overview of prospects and applications while stressing emerging areas of animal biotechnology.

**1. Introduction**

The application of biotechnology to animals has a long history, beginning in Southwest Asia after the last ice age, when humans first began to trap wild animal species and to breed them in captivity, initially for meat and fiber and later for transport and milk (National Research Council, 2002). In 1973, American geneticist Stanley Cohen and American biochemist Herbert Boyer removed a specific gene from one bacterium and inserted it into another using restriction enzymes. That event marked the beginning of recombinant DNA technology, or genetic engineering (Singh, 2018). Genetically engineered poultry, swine, goats, cattle, and other livestock also are beginning to be used as generators of pharmaceutical and other products, potential sources for replacement organs for humans, and models for human disease. The technology and effective use of genetic manipulation has encouraged the researchers to produce foreign proteins in milk by expressing novel genes in the mammary glands of livestock already has advanced beyond the experimental stage, with some of the products currently in clinical trials (Colman, 1996; Murray and Maga, 1999). Theoretically, transgenic animals can provide milk that is more nutritious for the consumer, or that is enhanced for certain protein components that might be valuable forBottom of Form manufacturing cheese or other dairy products. According to the Food and Agriculture Organization of the United Nations (FAO) report, ―The future of Food and Agriculture‖ the population of world is predictable to upsurge by 2 billion people in the next 3 years, from 7.7 billion recently to 10 billion by the end 2050. As a consequence of increased demand for meat and the deterioration and loss of agricultural land, there is pressure to utilize the potential for biotechnology to improve productivity in animal agriculture (National Research Council, 2002). As the techniques for producing transgenic animals become more efficient and as more is known about controlling how inserted genes are expressed, it is likely that the approaches soon can be integrated into agriculture. The application of advanced genetic engineering practices powered by the new breakthrough and innovations are the keystone of this report.

**1.1 Historical Background**

It is of usual thing to observe that humans have practiced biotechnology—utilization of organisms, part of organisms, and biological processes for the benefit of mankind—from the earliest times. Genetic modification dates back to earliest forms of domestication and cultivation. Darwin (1868) distinguishes two forms of this practice: conscious (or methodical) selection, and unconscious selection. He suggests that in early associations between humans and non-humans, it is natural for humans to select strong and healthy plants and animals, and promote their generation (Holland & Johnson, 1988). That way, the race would be subtly modified unintentionally; this was unconscious selection. The conscious methodical process of genetic modification through selective breeding has been practiced for thousands of years, though increased advances can be seen in the past 200 years. It involves controlling the hereditary characteristics of a plant or animal population, with the intention of making them more serviceable to human needs (Holland & Johnson, 1988).

**2. Advances in Animal Biotechnology**

Animal agriculture is being transformed by rapid advances in biotechnology—a term that encompasses a variety of technologies, including genetic engineering (GE), genetic modification, transgenics, recombinant DNA techniques, and cloning, among others. These advances have given people the potential to dramatically alter animals for a broad range of purposes, including food production, medical, and scientific research (Singh, 2018). Modern biotechnology represents the intersection of man’s manipulation of the environment and the emergence of molecular and computing technologies. Producers are interested in the application of biotechnology to improve productivity, consistency, and quality; to introduce new food, fiber, and medical products; and to protect the environment.

**2.1 Animal Cloning**

Cloning is one of the most recent evolution of selective assisted breeding in animal husbandry. Cloning animals is a reliable way of reproducing superior livestock genetics and ensuring herds are maintained at the highest quality possible (Bio, 2010). What this means is that the genes or DNA from one organism are copied, and a new organism - a genetic replica - created from it (Fisher, n.d.). Cloning is not essentially ‘new’, in 1952 researchers took an embryo from a frog and cloned it creating an exact copy of the original frog.

In the year 1997 the Scottish group (Roslin Institute) of researchers reported that they had cloned Dolly, from the DNA contained in the mammary cells of Dolly's 'mother'. Instead of using the early differentiated cell of a sheep embryo, they took a differentiated somatic cell from a mammary gland culture and produced a cloned embryo which, as before, was allowed to develop and then implanted into a surrogate ewe which eventually gave birth to Dolly (Fisher, n.d). What made Dolly so special was that she had been made from an adult cell, which no-one at the time thought was possible.

Since the production of sheep Dolly, the somatic cell nuclear transfer (SCNT) technique gained momentum and widely used to clone the livestock animals (Jena & Malakar, 2017). The SCNT is basically of two categories: Traditional cloning (using micromanipulator), and Handmade cloning (HMC). The HMC technique is the form of SCNT, in which there is no need of micromanipulator (the main costly equipment used in traditional SCNT) for the cloning process, and all the steps are done by hand. (Jena & Malakar, 2017). The technique has gained popularity due to the low cost involved in producing the cloned animal and not much expertise required to perform this technique. This method can be used not only in intra-species cloning but also in inter-species cloning (iSCNT) for endangered species conservation, transgenic animal production, regenerative therapy, and creating disease model (Jena & Malakar, 2017).

Several mammals — including sheep, mice, cows, goats, pigs, rabbits, cats , a mule , a horse and a litter of three rats — have been cloned using the SCNT technique, however, this technology has not so far been successful in dogs because of the difficulty of maturing canine oocytes in vitro (Lee et.al., 2018). After several attempts, the Department of Theriogenology and Biotechnology at [Seoul National University](https://en.wikipedia.org/wiki/Seoul_National_University), successfully created the first ever dog clone in 2005, named Snuppy. Since then, somatic cell nuclear transfer (SCNT) in dogs has been widely applied for producing several kinds of dogs with specific objectives (Lee et.al., 2018). A reliable and well-established cloning procedure provides unparalleled opportunities for the propagation of endangered species, companion dogs and service dogs as well as the production of transgenic dogs for human model research (Lee et.al., 2018).

**2.2 Transgenic Animals & Genetic Engineering of Animals**

A transgenic animal is one that carries a foreign gene that has been deliberately inserted into its genome (Frazier, 2018). It is one that has been altered to have specific characteristics it wouldn’t normally have. In animals, transgenesis either means transferring DNA into the animal or altering DNA of the animal (Frazier, 2018). Currently, 95% of transgenic animals used in biomedical research are mice. Before, no transgenic animal and animal products were approved by the FDA for human consumption. However, in November 2015, the USFDA just approved the first genetically modified animal--which is fish--for human food consumption. Transgenesis is a completely new technology for altering the characteristics of animals by directly changing the genetic material.

*Fabrication of transgenic animals.*

In Gupta et.al (2018)’s article, there are three fundamental methods used for producing transgenic animals:

a. DNA Microinjection

The DNA microinjection, a very fine glass pipette is used to manually inject DNA from one organism into the eggs of another. Better time for injection is early after fertilization when the ova have two pronuclei. They fused to form a single nucleus, the injected DNA may or may not be taken up. Through the DNA microinjection, the ovum is transferred into the oviduct of recipient female or foster mother that has been induced by mating with a vasectomized male. The University of California (Irvine) Transgenic Mouse Facility reports an estimated success rate of 10% to 15% based on experiments with mice testing positive for the transgene.

b. Embryonic stem cell-mediated gene transfer

A second method of creating transgenic mice is embryonic stem cell-mediated gene transfer. It is the introduction of DNA into embryonic stem cells. ES cells are from the very early mouse embryo and can differentiate into all types of cells when introduced to another embryo. DNA introduced into ES cells may integrate randomly, just like in pronuclear microinjection. If the introduced DNA is like as in sequence to part of the mouse genome, it may undergo "homologous recombination" and integrate as a single copy at a specific site.

c. Retro-virus mediated gene transfer.

In this method gene transfer is mediated by a carrier or vector. Retroviruses are commonly used as a vector that carries its genetic material in the form of RNA rather than DNA. Its transfer own genetic material into the cell, taking advantage of their ability to infect host cells. Offspring consequential from this method are chimeric, i.e., not all cells carry the retrovirus

*Transgenic cloned dogs.*

Reproductive technologies for genetic modifications used to produce transgenic animals have improved considerably in the past few years. In Lee et.al. (2018)’s dog cloning review article, this unique technology has emerged as an attractive method for genetic modification of dogs because there are some advantages to generating transgenic dogs by using SCNT. In 2009, transgenic dogs which globally expressed a red fluorescent protein (RFP) gene as a reporter gene have been generated. An assessment of the reproductive ability was performed in RFP transgenic dogs to identify whether those RFP genes were successfully inherited to the offspring. In 2011, a cloned transgenic dog conditionally expressing a green fluorescent protein gene was generated by using a doxycycline- inducible vector system. These established procedures for transgenic research for dogs open up the possibility to generate new trans-genic dogs and their applications to future biomedical research.

*As models in translational biomedicine*

Recent revolutionary transgenic approaches have significantly increased the power of translational biomedical research. For instance, genetic animal models of brain disorders such as schizophrenia, bipolar disorder, depression, Parkinson’s disease and attention deficit hyperactivity disorder have been created. Such animal models are the valuable tools for the study of aetiology and pathogenesis of human disorders. Transgenic mouse models have also become powerful tools for gene-based drug discovery and development. Their reproductive and nervous systems resemble those of humans, and they suffer from many similar diseases and syndromes, such as cancer, diabetes mellitus and even anxiety. Manipulating their genes can lead them to develop other diseases that do not naturally affect them, and as a result research on mice has helped understanding of both mechanisms of human health and the causes of disease.

*Recombinant Protein*

Genetic engineering for a protein of interest has been one of the advances in animal biotechnology. The transgenic livestock serves as potential bioreactors for the production of valuable proteins ionally stable recombinant biomolecules. Recombinant nutraceuticals and therapeutics produced from transgenic animals include omega-3 fatty acids, human serum albumin (Luo et al. 2015), recombinant human bile salt-stimulated lipase (rhBSSL) (Wang et al. 2017).

Major milk-specific proteins are casiens and whey proteins, most of which have been cloned and are well characterized. According to Frazier (2018), in their publication, the mammary gland can produce greater than 10 grams of recombinant protein per liter of milk per day.

**Conclusion**

With all the glory that the advances in animal biotechnology the author had discussed above, this does not mean that there are no concerns or even dangers posed by their use, or that there is universal acceptance among the public. The experience of past researches and experiments, if nothing else, illustrates that there must be continued vigilance even after technologies have been approved. Conversely, it should be recognized plainly that increases in agricultural efficiency brought about by new technologies, such as those discussed above, undoubtedly have contributed to a more abundant, cheaper, more varied and lower cost food supply, and to enormous savings in agricultural land. In addition, the government agencies involved in the regulation of animal biotechnology, mainly the Food and Drug Administration (FDA), likely will rule on pending policies and establish processes for the commercial uses of products created through the technology.

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