

SOME ASPECTS OF POULTRY BIOTECHNOLOGY: A REVIEW

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ABSTRACT

Animal biotechnology is the application of scientific and engineering principles to the processing or production of materials by animals to provide goods and services. Sometimes the animal biotechnology has been limited to genetic-based biotechnology only. However, the animal biotechnology uses the other, different techniques, such as artificial insemination, embryo transfer, *in vitro* fertilization, embryo culture, cloning by nuclear transfer from embryonic or adult somatic cell, etc. Due to the specificity of embryonic development in birds, which occurs inside the egg, the growing embryo can be directly manipulated via a window that is cut on the eggshell at a very early embryonic stage. This fact was used to develop *in ovo* technology – direct administration of a bioactive substance suspended in a solution to the incubating egg. This review integrates recent progress and new insights into methods of transgenic bird production (A), and possibility to modify the avian development (B).

Key words: chicken; biotechnology; transgenesis; *in ovo*

INTRODUCTION

A. Avian transgenesis

The production of transgenic birds has been hampered by the yolk-laden structure of the ovum and their unique reproductive system. The transgenic chickens have been produced by two different procedures, in general. The first is based on the viral transfection systems and the second non-viral, uses the genetically modified embryonic cells, transferred directly into the recipient embryo. Although viral transfection systems allows for efficient introduction and expression of transgenes in chicken dividing and non-dividing cells also (McGrew *et al.*, 2004), they have some important limitations: (i) restriction in the size of the vector genome to less than 8 to 10 kb (Byun *et al.*, 2011), (ii) vector insertion can cause the disruption of endogenous genes by insertional mutagenesis or the transactivation of neighboring endogenous genes (Li and Lu, 2010), (iii) integrated lentiviral vectors are subject to positional effects (Yi *et al.*, 2011). However, the much more

important limitation is a public concern, which has questioned the safety of lentivirus-based technology. In this situation some alternative strategies were developed, and the idea of generation of transgenic chicken through chimeric intermediates was described (Raynaud, 1976; Petite *et al.*, 1990). The generation of transgenic chickens has been attempted through chimeric intermediates produced by the transfer of blastodermal cells. The same idea was proposed in many other experiments, however in this case primordial germ cells (PGC), precursors of gonads, were proposed as the vehicle for introduction the transgene into the chicken genome. PGCs are especially increasingly being used in research on the development of chicken bioreactor. Chicken bioreactors provided, among others, human erythropoietin (Koo *et al.*, 2010), interferon alpha- 2b (Rapp *et al.*, 2003), interferon beta-1a (Lillico *et al.*, 2007), monoclonal antibodies (Kamihira *et al.*, 2005), granulocyte colony stimulating factor (G-CSF) (Kwon *et al.*, 2008). Genetic modifications may also be used in reducing the negative impact of poultry

production on environment condition. Introduction of salivary phytase transgenes into chicken can solve the problem of environmental pollution with phosphorus, by forcing its distribution in the body of animal (Sang, 2003).

Now, the novel, promising strategy, allowing efficacious enrichment of manipulated chicken PGCs on the basis of genome editing, has been proposed (Park *et al.*, 2014; Oishi *et al.*, 2016). Highly efficient and precise genome editing tools are actively adapted in poultry species, and in the near future will create the new bioindustry in poultry (Han *et al.*, 2016).

B. Modification of avian development

Generally, *in ovo* method enables the administration of a bioactive substance: carbohydrates, fatty acids, amino acids, minerals, vitamins, nanoparticles, prebiotics, probiotics or synbiotics directly to the incubating egg. As a consequence, *in ovo* delivery of bioactives not only have improved performance traits, such as the growth rate, feed intake, nutrient digestibility (Ohta *et al.*, 1999; Bednarczyk *et al.*, 2011) and meat quality (Maiorano *et al.*, 2012), but also significantly increased activity of some enzymes (Liu *et al.*, 2013; Pruszyńska-Oszmałek *et al.*, 2015) and influenced immune system development and function (Bhanja and Mandal, 2005; Bakyaraj *et al.*, 2012; Ślawińska *et al.*, 2014; Madej and Bednarczyk, 2016; Madej *et al.*, 2015; Płowiec *et al.*, 2015).

CONCLUSION

Thanks to these new techniques of cells isolation, manipulation and modification, as well as thanks to *in ovo* embryogenesis modification, bird biotechnology has had, and will also certainly have in future, important place in the improvement of animal health and productivity.

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