Genetic System to Selectively Generate Single-Sex Chickens

A novel method that allows single-sex systems to mprove animal welfare, reduce costs, and increase production efficiency.

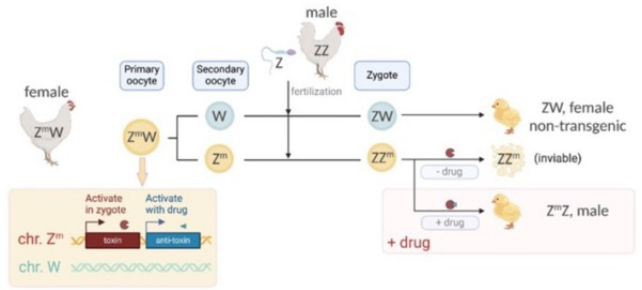

Figure 1. An overview of the genetic engineering system of single-sex chickens.

Technology

The inventors have developed a novel technology to selectively eliminate male zygotes (carrying ZZ chromosomes) without any impact on female zygotes (carrying ZW chromosomes) by using a 'toxin/anti-toxin' system. The 'toxin' is a ribonuclease enzyme that can cleave RNA and lead to cell death, while the 'anti-toxin' is a small protein able to bind and inhibit the activity of the 'toxin'. In this system, an exogenous 'toxin/anti-toxin' cassette is inserted on the hen's Z chromosome under the control of a specific promoter that can only be temporarily activated in zygotes and silent in other stages of development or in adult chickens. Because the sex of the offspring depends on the sex chromosome inherited from female chickens (Z or W), this method selectively eliminates zygotes inheriting a Z chromosome from hens (ZZ, male zygotes) without influencing zygotes with a W chromosome from hens (ZW, female zygotes). The switch for turning off toxin-mediated zygote killing is controlled by its 'anti-toxin', a gene inserted alongside the toxin on the Z chromosome. The expression of the 'anti-toxin', which is regulated by the TET-on promoter, can be induced by a drug, enabling the feeding of female chickens with the drug to prevent the 'toxin' from killing male zygotes.

Background

Chicken eggs are a major source of protein worldwide, with the US being the second-largest egg-producing country, providing 96.9 billion eggs in 2020. However, male chicks are not useful for egg-laying or meat production, and they are therefore killed on the day they are born, a practice known as *chick culling*. More than 260 million male chicks are killed each year in the US,

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Gina Tomarchio
Jane Liew

Authors

Teresa Davoli, PhD
Jef Boeke, PhD

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which raises important ethical concerns. In addition to this, distinguishing the sex of chicks is also time-consuming and expensive. New methods, such as in-ovo sexing, have been developed, but they require expensive and specialized instruments.

Applications

- Use in egg industry to selectively eliminate male zygotes without any impact on female zygotes, allowing exclusively female chicks to be born.
- Potential use in broiler industry, as females have higher fat content and thus better “mouthfeel” whereas males produce more protein by weight.

Advantages

- **Efficient and sustainable:** this method eliminates the need for the time-consuming and expensive process of egg or chick sexing and avoids the ethical issue of chick culling.
- **Broadly-used system:** ‘Toxin/Anti-toxin’ technology is already widely adopted in agriculture to produce male-sterile wheat plants or tobacco plants.
- **Non-GMO by-products:** Exogenous DNA is only inherited by male zygotes and removed when they die, ensuring the complete absence of exogenous or recombinant DNA in the eggs intended for human consumption.
- **Reversible:** The ‘toxin’-mediated killing of male zygotes can be turned off by inducing the ‘anti-toxin’ gene.

Intellectual Property

Provisional patent pending