In ovo vaccination helps hasten early immunity development in chickens

Technical Bulletin

Recombinant vaccines, such as Poulvac® Procerta®, pair well with Embrex® *in ovo* vaccination devices to help deliver strong early protection against viral challenges.

In ovo vaccination helps support an earlier and more efficacious immune response

At hatch, chicks can be exposed to health challenges, such as Marek's disease virus (MDV), Newcastle disease (ND) and infectious bursal disease (IBD), and their immune systems may be too underdeveloped to protect against infection.[1] The newly hatched chick's immune system may take one to two weeks to fully mature,[2] creating a period of vulnerability.

Vaccines based on herpesvirus of turkeys (HVT) applied *in ovo* help hasten maturation of the chicken embryo immune system, shifting the onset of immunity closer to hatch[3] and allowing the chick to respond to a disease challenge sooner.[1-2,4] Optimum timing for *in ovo* vaccination is 17.5 to 19.2 days and should be refined through embryo stage scoring.[5]

In a study, chickens vaccinated against MDV at 17 days of incubation had a lower incidence of lesions when challenged with MDV during the first five days after hatch compared with birds vaccinated at hatch, demonstrating that *in ovo*-vaccinated chicks initiated a prehatch immune response (Figure 1).[4]

Key takeaways

- ✓ *In ovo* vaccination with Embrex systems helps protect chicks at hatch[3] and helps reduce the window of vulnerability for disease challenges like MDV, ND and IBD compared with subcutaneous vaccination.[6]
- ✓ Effective *in ovo* vaccination helps enable additional immune system benefits such as support to help fight off unrelated disease pressures.[7]
- ✓ Hatcheries may benefit from using advanced recombinant vaccines, such as Poulvac® Procerta®, in combination with Embrex *in ovo* vaccination for disease protection.
- ✓ Delivering vaccine to the proper location within the egg during *in ovo* vaccination helps trigger the best immune response.[8]

Percentage of Dead and MDV Lesions After RB1B Challenge

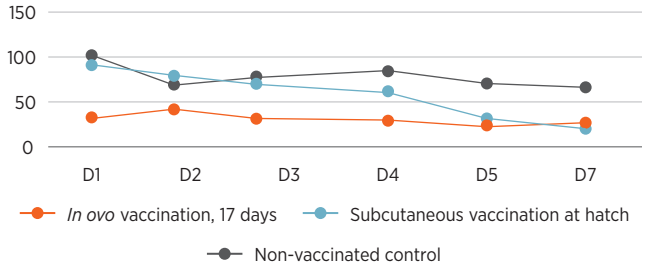

Figure 1. An MDV challenge study compared chicks vaccinated *in ovo* at Day 17 of incubation with chicks vaccinated subcutaneously at hatch against MDV. It showed that the *in ovo*-vaccinated group had a lower incidence of lesions at days 1-5 after challenge compared with the subcutaneous-vaccinated group, demonstrating that an *in ovo*-vaccinated chick has protection up to five days earlier.[4]

Apply recombinant vaccines *in ovo* to get more from early immunity

Recombinant vaccines — such as Poulvac® Procerta® — that are based on HVT, are commonly used with *in ovo* vaccination systems. The HVT virus — related to MDV and conferring protection against MDV — is a large virus, and that helps make it a good candidate for gene inserts from other viruses (particularly ND virus, IBD virus and infectious laryngotracheitis).[7]

Research has shown that replication of recombinant or rHVT is greater when administered *in ovo* than when administered subcutaneously at day of age.[7]

Since rHVT vaccines are cell-associated, they may overcome maternal antibodies and confer lifelong protection because they establish latency and periodically reactivate in long-lived birds.[7]

Research has demonstrated that *in ovo* vaccination with HVT also can hasten maturity of the chick embryo immune system. *In ovo* administration of HVT at 18 days of incubation resulted in innate and cell-mediated immunity at levels comparable to chicks 1 to 2 weeks of age.[2]

Earlier development of the immune system via *in ovo* vaccination helps protect young birds against pathogens unrelated to those they've been vaccinated against. In a study, a group of chicks were given an HVT *in ovo* vaccination. A second group received a sham or diluent-only *in ovo* vaccination. All the *in ovo*-vaccinated chicks were exposed to KLH at Day 1, an unrelated antigen. Unvaccinated 7- and 14-day-old chicks were also exposed to KLH at Day 1, Day 7 and Day 14, respectively. When KLH antibodies were evaluated a week later, 100% of the HVT *in ovo* vaccinated chicks developed detectable antibodies to KLH, as well as 100% of the unvaccinated 7- and 14-day-old chicks. Only 20% of the sham *in ovo* vaccinated chicks developed detectable KLH antibodies.[2]

When all the chicks were exposed to KLH a second time, the antibody activity level for the HVT *in ovo* vaccinated chicks was much higher compared to the sham *in ovo* vaccinated group. Comparing the HVT *in ovo* vaccinated chicks to the unvaccinated 7- and 14-day-old chicks, the HVT-*in ovo* vaccinated chicks had 61% of the KLH antibody activity compared to the 7-day-old chicks (46.7% compared with 76.4%). This shows *in ovo* vaccination helps enhance maturation of the chicken immune system. Previously it was thought that chicks do not develop humoral immune response until 1 to 2 weeks of age.[2]

In ovo vaccination not only helps with adaptive immunity through development of antibodies (humoral immunity) but also helps chickens develop cell-mediated immunity — an immune response that helps fight pathogens by destroying infected cells that display certain proteins known as antigens on their surface. A study showed that *in ovo* vaccination with HVT produced a greater cell-mediated immune response, as measured by lymphocyte production, than subcutaneous vaccination (Figure 2).[2]

Lymphocyte Mitogen (Con–A) Proliferation Cell–mediated Immune Response

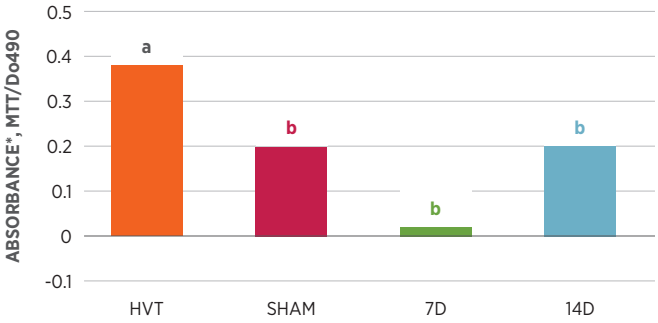

Figure 2. Chickens vaccinated through *in ovo* vaccination (HVT) experienced a greater cell-mediated immune response (lymphocyte mitogen proliferation) than birds vaccinated subcutaneously.[2]

**Absorbance is a measure of how much light is absorbed by a sample. In this case, the more light absorbed (taller bars), the more cell-mediated immune cells (lymphocytes) present in the sample. Concanavalin A (Con-A) is a type of immune stimulant used in research. Sham-inoculated chickens indicates diluent only.*

In ovo vaccination not only helps with adaptive immunity through development of antibodies (humoral immunity) but also helps chickens develop cell–mediated immunity.

Another study showed that *in ovo* vaccination with HVT can bolster chicks' immune systems through increased transcription of immune modulators in the spleen as well as the activation of macrophages and T cells.[9] These immune modulators, such as toll-like receptors and interferon, help assist with immune response and the immune system's ability to detect and protect against potential disease threats (Figure 3).

A Comparison of Immune Response Indicators in Chick Spleens

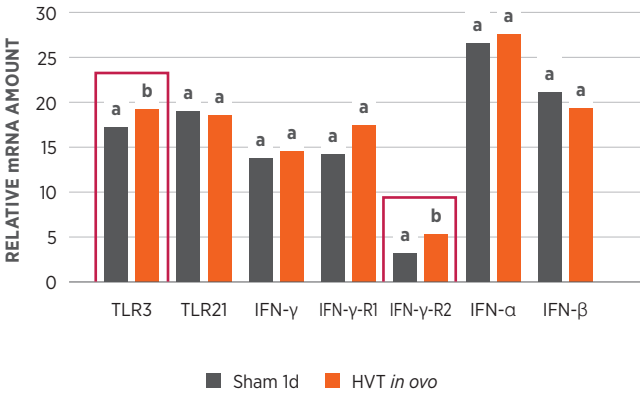

Figure 3. According to a study, 1-day-old *in ovo*-vaccinated (HVT) chicks had a significant increase in transcription of toll-like receptors (TLR) and interferon (IFN gamma) in the spleen compared with sham or diluent-inoculated chicks, which can indicate an increased ability for the immune system to detect and help protect against potential disease threats.[9]

Poulvac® Procerta® recombinant vaccines can pair well with Embrex® BioDevices

The fast-acting line of Poulvac® Procerta® vector vaccines are designed to help protect against costly viral challenges. The pairing of Embrex® *in ovo* vaccination systems with Poulvac Procerta vaccines can enable great value and optimum results from a hatchery vaccine program.

- ✓ Poulvac Procerta HVT-ND, offering protection against MDV and ND virus, showed 93% to 98% protection at 19 days of age when administered with an Embrex *in ovo* vaccination system on Day 18 of incubation.[10]
- ✓ To help protect against IBD, Poulvac Procerta HVT-IBD helps protect chicks fast and helps deliver strong overall protection to contemporary IBD virus challenges, demonstrating protection against IBD virus in chicks with high maternal antibody levels.[11,12]
- ✓ In a study comparing with a competitor, Poulvac Procerta HVT-IBD provided the earliest protection against vvIBD challenge — Day 12 — when administered *in ovo*.[13]
- ✓ Another study, comparing with a competitor, showed Poulvac Procerta HVT-IBD provided the highest protection against classic IBD challenges at Day 14 when administered *in ovo*.[12]
- ✓ Poulvac Procerta HVT-IBD-ND, an advanced dual vector vaccine, delivers powerful early protection against three diseases — MDV, IBD and ND — through a single-dose vaccine.[14,15]
- ✓ A study showed Poulvac Procerta HVT-IBD-ND provided protection against a vvIBD challenge at Day 18 when administered *in ovo*.[14]
- ✓ Another study showed Poulvac Procerta HVT-IBD-ND provided early protection against a velogenic ND virus challenge at Day 21 when administered *in ovo*.[16]

EMBREX®

Contact your local Zoetis representative or visit Embrex.com to learn more about Embrex® and hatchery services from Zoetis.

Note: Product information, registration and availability may vary by country and may change without notice. Contact your local Zoetis representative for details.

[1] Boone AC, Kaser T, Cortes AL, et al. In ovo vaccination with herpesvirus of turkey enhances innate and cellular responses in meat-type chickens: Effect of vaccine dose and strain. Vaccine. 2020;38:4837-4845.

[2] Gimeno IM, Faiz NM, Cortes AL, Barbosa T, Villalobos T, Pandiri AR. In Ovo Vaccination with Turkey Herpesvirus Hastens Maturation of Chicken Embryo Immune Responses in Specific-Pathogen-Free Chickens. Avian Dis. 2015;59(3):375-383.

[3] Avakian AP, Wakenell PS, Bryan T, Schaeffer JL, Williams CJ, Whitfill C. In ovo administration of Marek's disease vaccine: Importance of vaccine deposition site in the fertile egg, in Proceedings. 51st Western Poultry Disease Conference 2002;119-131.

[4] Zhang Y, Sharma JM. Early Posthatch Protection Against Marek's Disease in Chickens Vaccinated In Ovo with a CVI988 Serotype 1 Vaccine. Avian Dis. 2001;45:639-645.

[5] Villalobos T. Optimal timing for in ovo vaccination — Understanding embryo development. Int Hatch Pract. 2014;28(4):15.

[6] Data on file, Study Report Nos. B812R-US-17-793, B815R-US-18-A46, B812R-US-17-847, B815R-US-19-B80, B815W-US-19-A92, B815R-US-19-B22, B812W-US-18-919, B812R-US-20-D91, B812W-US-18-A07, B812W-US-18-A06, B812R-US-20-D24 and B815R-ES-20-C53, Zoetis Inc.

[7] Gimeno IM, Cortes AL, Reilley A, et al. Study of Efficacy and Replication of Recombinant Vector Vaccines by Using Turkey Herpesvirus Combined with Other Marek's Disease Vaccines. Avian Dis. 2019;63:335-341.

[8] Avakian AP. Understanding *in ovo* vaccination. Int Hatch Pract. 2006;20(5):15-17.

[9] Boone AC, Kulkarni RR, Cortes AL, Villalobos T, Esandi J, Gimeno IM. In ovo HVT vaccination enhances cellular responses at hatch and addition of poly I:C offers minimal adjuvant effects. Vaccine. 2023;41:2514-2523.

[10] Data on file, Study Report Nos. B815W-US-18-964 and B815R-US-18-A46, Zoetis Inc.

[11] Data on file, Study Report Nos. B815R-US-19-B80, B815W-US-19-A92, B815R-US-19-B22, B814R-US-19-B15 and B818R-US-19-B94, Zoetis Inc.

[12] Data on file, Study Report No. B812W-US-18-919, Zoetis Inc.

[13] Data on file, Study Report Nos. B811W-US-19-B11, B812W-US-18-A52 and B812R-US-19-A87, Zoetis Inc.

[14] Data on file, Study Report No. B812R-US-20-D91, Zoetis Inc.

[15] Data on file, Study Report Nos. B812W-US-18-A06 and B812W-US-18-A07, Zoetis Inc.

[16] Data on file, Study Report No. B815R-ES-20-C53, Zoetis Inc.

zoetis