Characteristics and functionalities of spray vaccination of poultry

Spray is the scattering of water droplets through the air. It is a method used to deliver vaccines effectively and efficiently to many chickens. During spray vaccination, water droplets meet the mucosa surfaces of the eyes, nares, mouth, oropharynx, and upper part of the trachea.

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The vaccine virus as well as respiratory field viruses replicate in these mucosa cells. With this action, the vaccine virus blocks field virus replication and stimulates the immune system, specifically cell-mediated immunity, and the in-situ production of, mostly but not exclusively, immunoglobulin A.

This article looks at the main characteristics and functionalities of spray vaccination and bio-devices for veterinary use in poultry.

Understanding droplet size

● **Droplet size concept:**
Any given spray vaccination bio-device generates a range of droplet sizes known as droplet size distribution.

Droplet size is normally referenced as the droplet diameter measured in microns (µm). Droplet size distribution is reported in terms of Dv0.1, Dv0.5, and Dv0.9 categories related to the volume sprayed.

Dv0.1 is the droplet size at which 10% of the total spray volume is made up of droplets that are equal to or smaller than the given droplet size.

At the other extreme, Dv0.9 is the droplet size at which 90% of the total spray volume is equal to or smaller than this given droplet size.

Dv0.5 is the volume median diameter; it is the droplet size at which 50% of the sprayed volume is made up of larger drops and 50% of the volume is made up of smaller drops.

Another metric to consider is relative span (RS), which reflects the uniformity of the droplet sizes in the spray in relation to the volume median diameter. The RS formula is RS = (Dv0.9 - Dv0.1) / Dv0.5.

The smaller the RS value (≤1.0) the lower the variance in droplet sizes and this translates to a more uniform spray. An RS value of 1.0 or less would be represented by a tight bell-shaped curve if the distribution were to be graphed.

A higher RS value (>1.0) indicates spray inconsistencies. Fluctuations in the pressure applied to generate the spray can cause extremes in droplet size and make for a wider bell-shaped curve if the distribution were to be graphed.

The objective of spray vaccination is to reach the upper respiratory tract of each bird. If the bio-device produces small droplets (<3.7 microns) then these droplets may penetrate too deep within the respiratory tract.

A desirable bio-device is one that can produce droplet sizes that reach the mucosae in the bird's head and anterior parts of the trachea.

● **Measuring droplet size:**
Spray droplets are measured in microns (µm), which equal one thousandth of a millimetre. For poultry, spray bio-devices are designed to reach no further than the upper respiratory tract even after the droplets will decrease in size due to evaporation and other environment factors. Laboratories use specialised equipment, such as the phase doppler interferometer and the laser diffraction particle size

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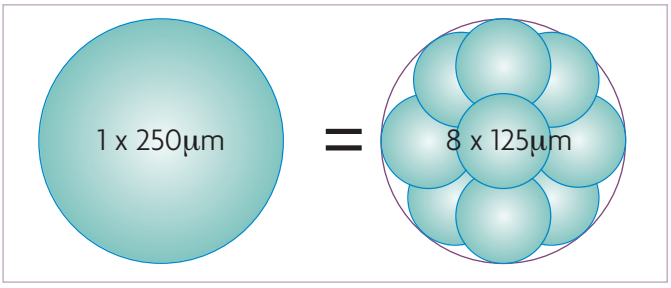
Fig. 1. Division of the droplet by half results in eight-fold the quantity of droplets.



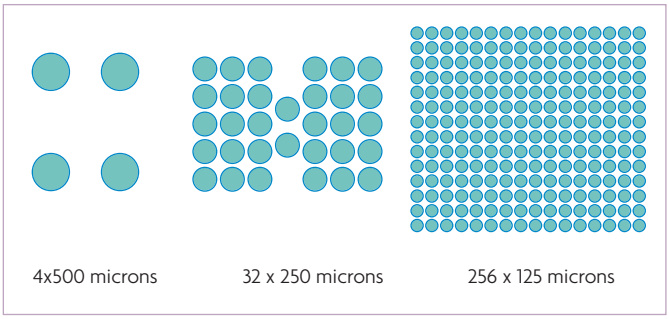


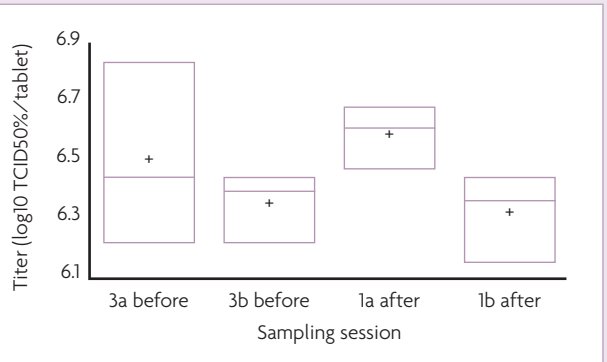
Fig. 2. The different coverage generated by three different droplet sizes (500, 250 and 125µm) using the same spray volume.

STUDY 1. Virus integrity after spray:

The following study shows the impact of spray on vaccine virus viability when evaluated by virus titration before and after spray.

The 793B serotype infectious bronchitis virus strain was used in in vitro tests aiming at comparing results between titration before and after spray using the Spra-Vac Line, a spraying bio-device for veterinary use (Fig. 3). The results showed no negative impact on tested vaccine titers throughout the spraying procedure.

Fig. 3. Tested live vaccine virus titers (IB 793 serotype virus strain) before and after contact with the tested spraying device.

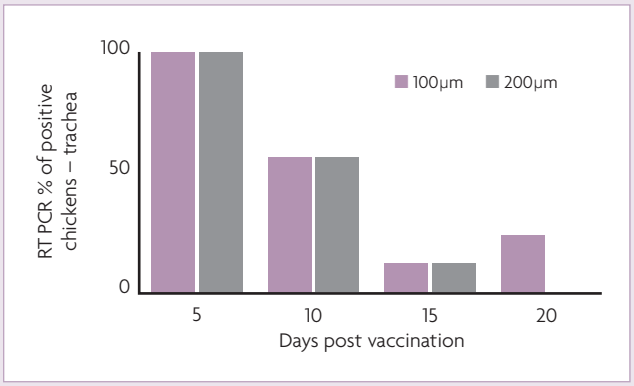


STUDY 2. Virus replication in the respiratory tract:

A RT PCR test was performed on the trachea and gut mucosae of SPF chickens and broilers vaccinated with the live Newcastle VG/GA Avinew live vaccine and sprayed via the Spra-Vac Line. Virus replication was evident after vaccination in both locations using 100 and 200µm droplet sizes.

The results for replication in the trachea of broilers are shown in Fig. 4. They show that the vaccine virus is replicating for two weeks post-vaccination in the respiratory tract, one of the locations for virus replication of this vaccine.

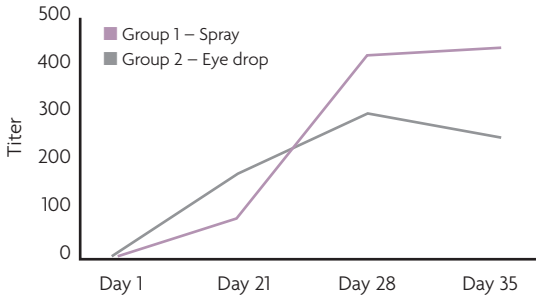
Fig. 4. Replication profile of the live vaccine VG/GA Avinew strain in the trachea of SPF chicks.



STUDY 3. Antibody detection in birds vaccinated by spray and by eye drop:

SPF chicks were vaccinated using the live infectious bronchitis vaccine Mass H120 strain and the Newcastle disease VG/GA Avinew by spray or eye drop using the Spra-Vac II at day of age. ELISA and HI serology tests were performed to monitor the antibody response. Results for infectious bronchitis are shown in Fig. 5 and evidence seroconversion post-vaccination. These results show that the immune system responds to the vaccination stimulus.

Fig. 5. Infectious bronchitis ELISA post-vaccination serological monitoring.



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analyser to accurately measure parameters like droplet size distribution, droplet uniformity, and spray pattern.

● **Other important physical characteristics of droplets and their distribution:**
When droplets are divided in half diameter, their number increases by eight (Fig. 1). As the number of droplets increase, the spray coverage will increase (Fig. 2).

To achieve the proper coverage, the droplet size and number of droplets must be correct. However, if the droplets are too small, they will drift and evaporate.

Conversely, if the droplets are too large, they will not provide adequate spray coverage; they will drop to the ground without reaching the target areas on the birds.

How to evaluate a spray vaccination bio-device

Bio-devices are evaluated by measuring the following parameters:

● **Engineering:**
- Droplet sizes.
- Droplet size distribution (DV0.5, DV0.1, DV0.9).
- Relative span.
- Percentages (amount) of droplet sizes.
- Coverage.
- Volume and consistency.
- Usability.
  - o Ease of use.
  - o Ease of cleaning.
  - o Efficiency.
  - o Durability.

● **Vaccination:**
- Virus integrity after spray.
- Virus replication in the bird.
- Post-vaccination antibody detection.
- Protection against viral challenge.

Examples of spray vaccination evaluations

The studies in the three inset boxes show the impact spray vaccination biodevices offered by Boehringer Ingelheim had on vaccine integrity after spray, virus replication in the respiratory tract, and antibody detection in birds vaccinated by spray compared to eye drop application. These studies validate the use of spray bio-devices for live vaccine application to day-old chicks.

Conclusion

Each sprayer within the Boehringer Ingelheim portfolio is designed and tested using advanced technologies to optimise droplet size and other main criteria for optimal spray vaccination.

The studies reported here show that the Spra-Vac Line and the Spra-Vac II sprayers do not impact the titer of the vaccine virus after the spraying process; they report that the vaccine live virus replicates in the chicks and induces the expected immune response.

This proves that the veterinary bio-devices are properly validated for spray vaccination.

Do not use any sprayer that is not specifically designed and validated for the administration of poultry vaccines. ■

References are available from the authors on request