

Coccidiosis Control in Broilers with the use of Vaccines

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INTRODUCTION

Coccidiosis is a disease of the intestinal lining, produced by the invasion of the mucosal cells by a very prolific protozoan parasite of the genus *Eimeria*. This invasion results not only in the interruption of feeding and digestive processes involved in nutrient absorption but also can cause intestinal inflammation leading to dehydration, blood loss, loss of skin pigmentation, and increased susceptibility to secondary bacterial infections like necrotic enteritis and osteomyelitis.

Coccidia are prevalent in almost any poultry facility where chickens are raised. Although normally a disease of young chickens, any aged chicken without prior exposure and immunity is susceptible to coccidia.

Clinical coccidiosis in broilers can be prevented by the use of anticoccidial medications (ionophores and non-ionophore anticoccidials [NIA]) in the feed. The objective has been to minimize coccidia cycling and intestinal damage to decrease the negative effects of coccidiosis on production performance indicators such as feed conversion ratio (FCR), average daily gain (ADG), as well as livability.

Although, anticoccidial medications have been used in different modalities (straight, shuttle or rotation) with excellent results, over time coccidia can develop resistance to them due to constant exposure, especially to most NIAs. Coccidiosis vaccines were initially introduced as a way to increase coccidia sensitivity to anticoccidial medication. Coccidiosis vaccines administered to broilers for 2-3 production cycles will help to regain maximum coccidiosis control and maintain excellent field performance. This is probably one reason for the successful use of coccidiosis vaccine in combination with an ionophore in a bio-shuttle program. A bio-shuttle program involves vaccinating chicks at the hatchery with a coccidiosis vaccine followed by feeding an anticoccidial around the end of the second coccidia cycle (not before day 14 and no later than 21 days of age). A bio-shuttle program allows for the modulation of coccidia cycling without interfering with the development of immunity.

Since the early 2000s, there has been a worldwide increase in the number of broilers raised in programs using less antibiotics in various forms. In addition, the use of antibiotic growth promoters (AGP's) is not allowed anymore in many countries. Furthermore, there has been a widespread increase of responsible use of antibiotics leading to the gradual reduction of use over the years including curative use when required. Recently, there has been a transition to No Antibiotics Ever (NAE) programs (e.g. in the USA). Because certain ABF programs, like NAE, are becoming more common, along with companies growing broilers to older ages, some chicken producers have successfully increased the use of coccidiosis vaccines from a few cycles a year to a year-round program.

EARLY IMMUNITY

When using a coccidiosis vaccine, achieving early immunity (within the first 3-4 weeks of a chick's life) is essential for ensuring long-lasting protection throughout their life. Vaccination at the hatchery is a controlled exposure method and the development of immunity to coccidia requires several consecutive cycles or passes through the bird in the field under particular management conditions.

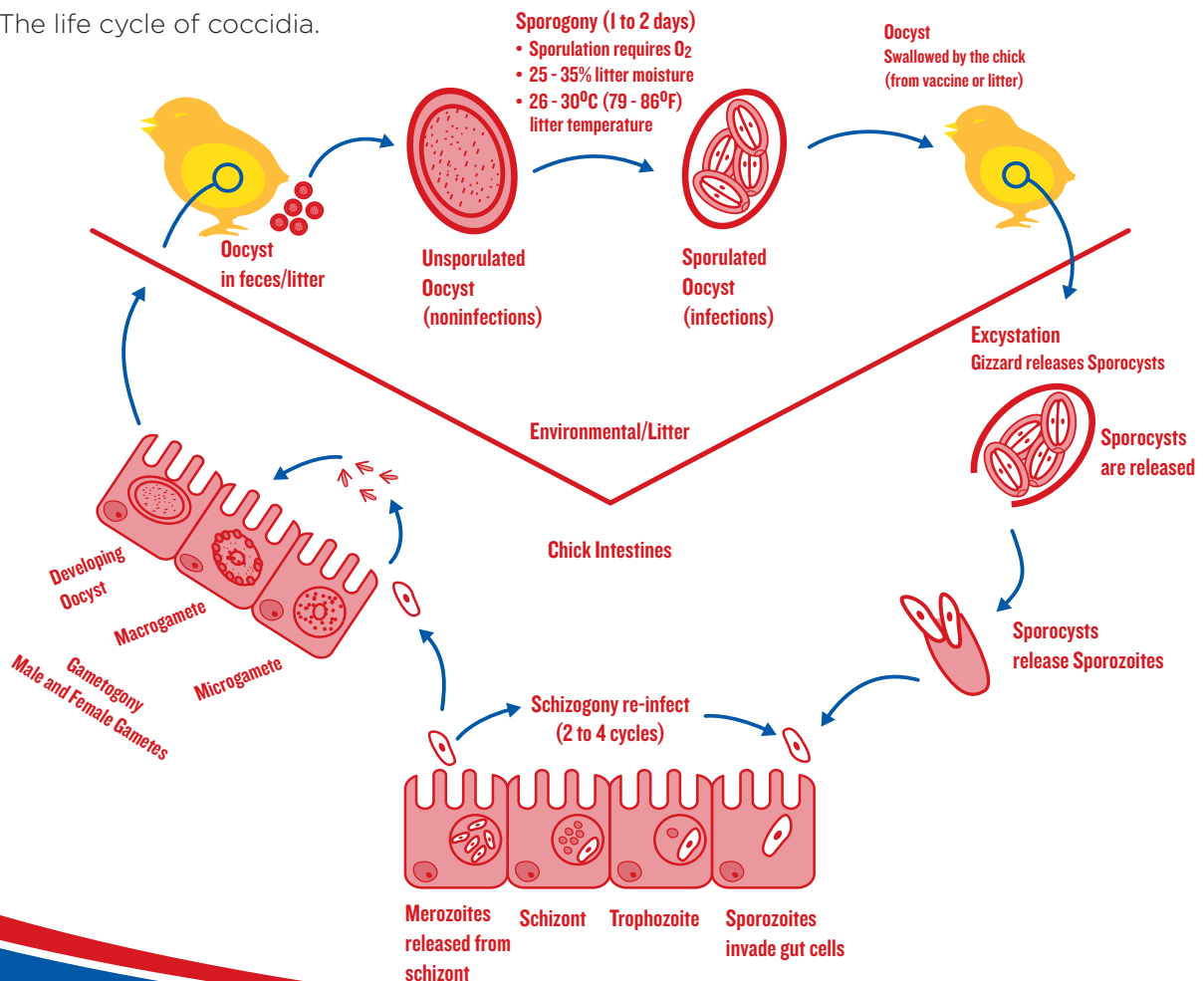
The first exposure to the coccidia parasite takes place during vaccination. Regularly, this vaccination occurs at the hatchery, and the rest of the cycling process continues on the farm (following exposure and cycling).

Each cycle requires the ingestion of sporulated oocysts by the bird. The parasite invades and multiplies within the intestinal cells several times, and the cycle ends with the shedding of the unsporulated oocysts in the feces. Then, under the right litter conditions (oxygen, temperature, and humidity), the oocysts sporulate in the litter, ready to repeat the cycle.

BIOLOGY AND LIFE CYCLE

The coccidia of chickens have a distinctive life cycle (**Figure 1**). Previously unexposed chickens get infected by ingesting sporulated oocysts (infectious) to start the cycle, from either vaccination or the litter. The cycle is composed of two stages; the first stage occurs inside the chicken (Schizogony and Gametogony), lasting around 5-7 days. The second stage occurs in the environment/litter (Sporogony) and lasts around 1-2 days, and this enables the oocyst to become infective. A sporulated oocyst has 4 sporocysts, and each sporocyst contains 2 sporozoites. After ingestion, the oocysts' walls are crushed by the physical activity in the gizzard, which releases the sporocysts (excystation process). Pancreatic enzymes in the small intestine then release the sporozoites from the sporocysts enabling them to infect epithelial cells and begin the cycle in the intestine of the bird.

Figure 1. The life cycle of coccidia.



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Immature oocysts shed by the bird remain dormant in the litter until specific litter conditions allow their sporulation. These conditions are:

- Oxygen
- Litter moisture of 25-35%
- Litter temperatures of 26-30°C (79-86°F)

It is essential to remember that for full immunity to develop, coccidia have to cycle in the bird 3-4 consecutive times. The length of the cycle and how many cycles are needed depends on the *Eimeria* species infecting the chicken. In general, the *Eimeria* species cycle between 5 and 7 days.

DIAGNOSIS

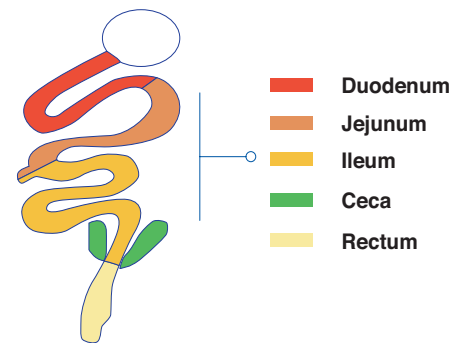
Seven known *Eimeria* species infect chickens. These species are host-specific, meaning that they only infect chickens and do not infect other species of birds. Diagnosis can be made by:

- Examining the location and the type of gross lesion found in the intestines. The parasite location and gross lesion in the intestines allow a presumptive rough diagnosis of the species of *Eimeria* involved, most of the time.
- Observing intestinal scrapings under a microscope to identify the species of *Eimeria* based on oocyst and schizont size and shape. The oocysts of *E. maxima* are remarkably large as compared with other species.
- Collecting and fixing intestinal tissue samples in a container of buffered formalin solution for a histological diagnosis.
- Taking advantage of DNA technology, including PCR and sequencing, to identify every species affecting the birds.

The following table shows the most common *Eimeria* species found in broilers and their prepatent period (time between exposure and shedding of the first oocyst).

Table 1. The three most common species of coccidia in broilers and their prepatent period.

<i>Eimeria</i> species	Parasitized Area of Intestine	Prepatent Period (hours)
<i>E. acervulina</i>	Duodenum	97
<i>E. maxima</i>	Jejunum and Ileum	121
<i>E. tenella</i>	Ceca	115



VACCINE, VACCINE ADMINISTRATION AND EFFECT OF VACCINES

There are different commercially available vaccines for use in broilers. Most vaccines are based on suspensions of live (viable) sporulated oocyst. They vary in the content of coccidia species, the number of oocysts, and strain pathogenicity. Also, coccidiosis vaccines can be originated from non-attenuated or selected precocious (attenuated) strains. Precocious strains cycle faster and are less pathogenic, but are also less prolific than the non-attenuated strains.

Most commercial vaccines available for broilers include *E. acervulina*, *E. tenella*, and *E. maxima*.

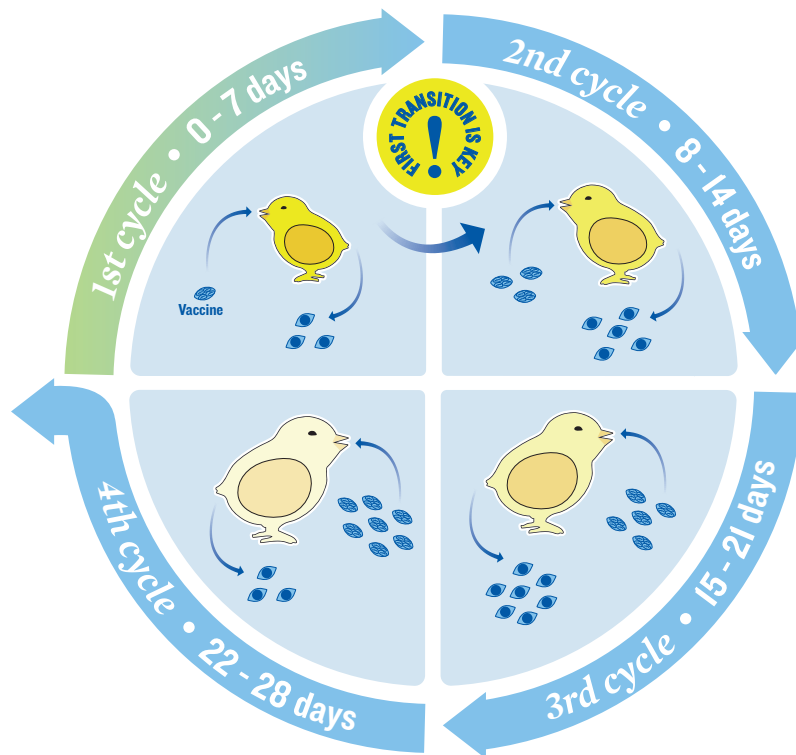
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Different methods have been used to administer live coccidiosis vaccines to broiler chicks. The vaccine has been applied in the feed or the drinking water during the first week of life. At the hatchery, vaccines have been administered by coarse spray, solid gel pucks, or *in ovo* vaccination. Today, most coccidiosis vaccines for broilers are administered at the hatchery either via spray cabinet mist or gel droplets, and in some situations, chicks are revaccinated in the field.

If the chick's intestine is healthy and the vaccine was adequately applied, live sporulated oocysts from the vaccine should replicate soon after their ingestion by the chick. The transition from the first to the second cycle is critical and must occur on the farm (**Figure 2**).

The next generation of oocysts shed by the vaccinated chicks must sporulate before being ingested again by the birds and replicate into a second cycle (this sporulation is highly dependent on proper environmental conditions). Then, following consecutive third and fourth cycles, robust immunity is achieved, and birds have protection against future coccidiosis challenges. Revaccination on the farm has been used in some operations to ensure adequate/uniform vaccine coverage and early oocyst cycling. Revaccination can be done using a coarse spray, in the water or feed, or oral gavage methods.

Figure 2. Early recycling of the *Eimeria* vaccine in the chick after vaccination.



The development of immunity is dependent upon the early cycling of coccidia. In addition to an excellent initial vaccination, it is essential to provide the right conditions for the birds to experience the proper cycling starting at day one (optimal brooding conditions for optimal intestinal development).

Disruption in the process of going from the first cycle to the second will cause some birds to start building immunity, while others remain naive to coccidia. Poor uniformity of immunity increases the risk of coccidiosis outbreaks due to challenges with high numbers of oocysts infecting a naive population of chicks. The consequences of these outbreaks are significant; treatment with anticoccidials may be required; bird welfare and performance will be adversely impacted, leading to financial losses.

Proper cycling ensures the development of immunity and results in:

- Better intestinal integrity
- Uniform feeding and feed efficiency
- Uniform body-weight gain
- Improved bird health and flock livability

FACTORS AFFECTING THE VACCINE RESPONSE DURING THE GROW-OUT

The factors highlighted below, either alone or in combination, impact the provision of an effective coccidiosis vaccination program. The best place for coccidiosis vaccination is at the hatchery, where conditions are ideal for mass application and there is usually better control over the vaccination preparation and mixing process.

Vaccine handling, storage, and administration

- Never freeze coccidiosis vaccine for it contains live oocysts.
- Follow manufacturer's instructions for mixing the vaccine with diluent.
- Ensure a uniform distribution of the vaccine via spray cabinet mist or gel droplets. Administering vaccine in a way that ensures equal exposure of all chicks to live oocysts is of paramount importance (use a dye if necessary).
- Provide birds with enough time and light intensity after vaccination in the hatchery to allow preening.
- Keep chicks comfortable in terms of temperature and relative humidity after vaccination. Allow chicks to dry and avoid exposing them to high air speeds or drafts.

Note: There may be situations where coccidiosis vaccine application on the farm should be considered as either the only vaccine applied or as a revaccination. These situations occur:

- When vaccines cannot be administered at the hatchery.
- When there are doubts about the vaccine application at the hatchery or,
- As a choice made by the customer for a better "take" on a particular species.

BROODING AND MANAGEMENT PRACTICES

Optimal brooding practices are essential for proper intestinal development and also for proper oocyst sporulation, consumption and recycling. Chick brooding density needs to change as the birds grow to increase floor space as well as feeding and drinking space. However, releasing chicks too soon into areas where coccidia oocysts have not been shed can compromise the recycling and uniformity of the process and development of immunity.

Management during the first few weeks of a chick's life is critical for intestinal development and requires a focus on many factors. Excellent management and proper environmental conditions include focusing on:

- Feed
- Light
- Air (Temperature and RH)
- Water
- Space (bird density and feeder and drinker space)
- Sanitation (biosecurity)



Partial house brooding is a common practice and a very effective way to achieve a suitable environment for chicks as well as the proper oocyst cycling. Brooding rings, brooding areas or partitions are used to control not just the stocking density, but also feeder and drinker space.

Controlling stocking density progressively during the first three to four weeks is an excellent way to influence litter humidity and temperature for optimal intestinal development, coccidia sporulation and cycling.

The stocking density during the brooding period needs to be adjusted based on particular housing and/or farm conditions (brooder type, brooding set-up, feeder and drinker type, house ventilation, litter humidity, and environmental temperature). Time of the year can also influence brooding conditions where countries with severe winter and summer seasons may need to make adjustments to brooding protocols.

If covering the brooding area with paper, and subsequently removing it, be sure to remove the paper before the chicks start shedding the vaccine oocysts (this usually starts 5 days after vaccination). Removing the paper later than day 4 after vaccination might reduce proper exposure to the vaccine oocysts that were shed by the birds limiting the first recycling of oocysts. If using paper in the brooding area another option is to leave the paper to decompose in the litter.

Managing the litter moisture and temperature requires close attention and is essential to the proper development of coccidia immunity. Spraying water on the litter may be required if the litter material is too dry (< 25% litter moisture) or if the proposed stocking density is too low to support litter moisture. Relative humidity is not a good indicator of litter moisture. Litter moisture can be checked using a handheld moisture meter or by simply picking up a handful of litter and subjectively assessing the moisture content. Squeeze a handful of litter, and if it remains in a clump, it is too wet. If the litter falls apart without clumping at all, it is too dry. Litter with the correct moisture content clumps slightly. Although less practical, litter moisture can also be measured using a drying oven. Samples of litter are collected, weighed, and allowed to dry in a drying oven for 12-24 hours at 50 °C (120 °F). Calculating the water loss determines the % litter moisture.

As explained earlier, litter temperature and litter moisture are crucial for oocyst to sporulate, but environmental conditions are also essential to allow proper chicken development. ***Refer to the Broiler Management Handbooks for more information regarding best management practices.***

VACCINE CYCLING

- Optimal intestinal development is critical. Check for 7-day body weight and uniformity. Intestinal development needs to be maximized during the first week.
- Continued cycling is the key to long-lasting immunity without a clinical coccidiosis break, especially the first cycle and the transition from the first to the second cycle. Remember that for a few chickens, the first cycle occurs on the farm.
- Under certain conditions, such as very low humidity in the litter, revaccination in the field during the first week along with wetting the litter to increase litter humidity might be advised to guarantee the first cycle.
- As mentioned earlier, density can also influence the litter humidity and the rate of oocyst ingestion and sporulation. Always keep density in mind during the first 3-4 weeks of age when dealing with coccidiosis challenges.
- Evaluate proper cycling in the field between 7 and 28 days with:
 - Clinical and necropsy observations of chickens in the field (avoid choosing sick birds).
 - Oocysts counts per gram of feces by laboratory analysis. This evaluation could help to determine if cycling is taking place according to plan or if there is an issue with the coccidia replication or vaccine application at the hatchery.
- Be aware of anticoccidial properties of any supplement given to the chickens as it may impact the vaccine cycling and development of immunity.
- In ABF production programs, the use of phytogenics, botanicals or plant extracts in the feed or water might be helpful in conjunction with the coccidiosis vaccine to try and modulate the cycling of the vaccine.

IMMUNOSUPPRESSIVE CONDITIONS

- Disease challenges like IBD, Marek's and CAV can have a detrimental effect on the birds' immune system and development of immunity against coccidiosis. Immunosuppression results in excessive replication of the coccidia, and breaks may occur later in life.
- Other situations can lead to immunosuppression including stress, mycotoxins, cold brooding temperature, lack of feeder space, or marginal nutrition.

ENVIRONMENTAL CHALLENGES

Some environmental conditions have an impact on the birds' response to the vaccine:

- Environmental challenges caused by temperatures going above or below the recommendations during the first weeks of life.
- Air quality challenges such as high ammonia or dust in the house could negatively impact the early development of chicks and their response to the coccidiosis vaccine making the chicks susceptible to other diseases.
- Dry litter conditions prevent the sporulation of oocysts.
- Wet litter conditions increase sporulation, which can lead to excessive sporulation of oocysts and lesions resembling coccidiosis breaks.

NUTRITIONAL FACTORS

- Mycotoxins in the feed can harm the birds' immune response resulting in a higher susceptibility to field challenges.
- Feed phase or feed form changes during the development of immunity to coccidia could cause intestinal changes in the birds and produce a suboptimal response to the vaccine.

TREATMENT

Although rare, sometimes birds may require treatment to control an outbreak. If and when the development of good immunity fails, birds may be at risk of a new coccidiosis outbreak if:

- Treatment is given too early before immunity builds (less than 2 weeks).
- A high dose of medication for more than 2 days is used eliminating the coccidia from cycling and compromising immunity.

Amprolium and Toltrazuril are among the medications being used to treat clinical coccidiosis outbreaks. In the past, sulfa medications have also been used as a treatment.

The use of anticoccidial medications or certain botanical products can interfere with the response to vaccination or the recycling of oocysts. Therefore, their use as part of a "bio-shuttle program" or a dual program coccidiosis vaccine/botanical must be managed and closely monitored to avoid vaccine failures. It is essential to consult and follow the vaccine manufacturer's recommendations.

Necrotic enteritis (NE) is sometimes seen as a consequence of vaccination, especially if improper cycling takes place. If NE is observed this usually requires treatment.

KEY POINTS

- Keep vaccine refrigerated (NEVER FROZEN) and watch expiration dates closely.
- Administer vaccine in a way that ensures uniform distribution and equal exposure of all chicks to live oocysts. Hatchery administration is recommended. Allow chicks to dry and avoid exposing them to high air speeds or drafts.
- Provide birds with enough time and light intensity after vaccination in the hatchery to allow preening.
- Good brooding practices (environmental temperature and relative humidity), along with controlling stocking density up to 21 days, will ensure that the recycling of oocysts is uninterrupted allowing full immunity to be achieved early.
- Revaccination on the farm may be necessary when conditions are not optimal.
- Regular field evaluation of the birds between 10 and 28 days is recommended to determine or observe the post-vaccinal reaction and make adjustments to the brooding and management program.
- When vaccinating for coccidiosis, the use of anticoccidial medications or any product with anticoccidial activity, especially during the first 3 weeks of life, is not recommended as it will interfere with the coccidia cycling and the development of early immunity.
- Check anticoccidial properties of any feed additive used in an ABF program.
- **ALWAYS** contact your veterinarian to discuss any treatment if needed.

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