Vaccinations and Coccidiosis

Coccidiosis is a rapidly reproducing, self eliminating protozoan whose host will naturally acquire immunity to over time through repeated ingestion [2,3,5,7]. Consequently, in today's intensively managed poultry industry time nor the loss in production that can result from mild to severe coccidiosis sufficiently allows for a "natural" developing immune system. The use of anticoccidials in the feed was the first product available to help aid against the performance loss caused by Eimeria spp. infestations. Unfortunately, the use of anticoccidials has led to the development of drug resistant strains and also requires a sufficient withdrawal time in which the bird may not be able to fight off an immune challenge during this time period [3,5,8]. To combat these issues the poultry industry has taken a significant interest in the use of vaccinations to combat the effects of coccidiosis. The first vaccination to hit the market was Coccivac in the United States in the early 1950's [2,3,8]. This vaccine was administered through the eye (ocular vaccination) and was very effective in developing immunity against Eimeria spp.; however it was also very labor intensive. Ocular vaccination has given way to other methods of administration such as spray-on feed, hatchery spray, edible gel, and in-ovo inoculation[2,3,6,8,9]. Vaccines are typically sprayed on the birds while in the hatchery trays in a bright color such as red or green. The chicks respond to the color by preening one another which allows for the immediate ingestion of oocysts prior to placement on the farm[2,3,8]. By decreasing the temperature, increasing the light intensity, and the sound intensity for a time period chicks become highly stimulated to preen on another[8]. Another popular method is providing the oocysts to the chicks in the hatchery through a gel formulation. Immucox allows for 4 different vaccination delivery options including gel form. In a study conducted by H.D. Danforth , Immucox in all forms provided adequate ingestion of vaccinal oocysts though gel form showed superior performance. Another advantage to vaccination through the gel formulation method is that birds are provided with a hydration source during a time period when dehydration consequences can cause severe long term performance deficiencies [2,8]. Stress has also been shown to induce susceptibility to cocci challenges along with negatively affecting the immune system[3]. To what magnitude stress places on a bird's ability to utilize its genetic potential is currently unknown; however, the stress induced during processing at hatch, transport, and brooding can effectively negatively impact the development of an early onset immune response.

Vaccines can be categorized as live or inactivated (killed). An inactivated vaccine is generally most effective against bacteria; the disease is killed in a lab and upon administration will elicit a weak immune response compared to live vaccines. For example vaccinations for Newcastle, Infectious Bursal Disease, and Salmonella are often killed vaccines. Often frequent dosages are required to maintain immunity which is very stressful on birds and also labor intensive. This method would not be effective against Eimeria spp. as cocci generate immunity through localization in the mucosal lining of the gut[5]. The ability to replicate is essential to elicit this localized immunity response necessary to allow the bird to combat coccidiosis. Live vaccines work by taking the live organism responsible for the disease and delivering it to the unaffected birds. The birds are exposed to a developing organism, in this case parasite, that begins immediate partial stimulation of the immune system. The live oocysts replicate and induce coccidiosis in the bird while also passing through the feces[1,2,3,6,8] . The oocysts from the

vaccine strains will often interbreed with the wild field strains which can be highly advantageous if the field strains have drug sensitivity to certain anticoccidial drugs. The recycling of infection by the Eimeria spp. induced by the vaccine strains is critical to the birds acquiring a fully protective immune system[2,3,8]. Acquiring early immunity is advantageous for several reasons [8]:

- Young chicks are the least valuable
- Young chicks are the least susceptible to cocci
- There is the least effect on weight gain and feed conversion efficiency
- The early period is before natural outbreaks occur
- The early period is prior to stressors that occur during the most rapid growth period
- If anticoccidial medication is required, costs are cheaper for younger birds than older birds

Research has shown that vaccinated birds reared on floor litter become immune to coccidiosis challenges while caged birds do not acquire immunity. Breeders who were vaccinated and raised on a litter floor up to 6 weeks of age maintained immunity for at least 18 weeks regardless of being reared on the same litter or transferred to separate housing [3]. In the case of birds who do not get adequate infected from vaccination the oocysts will pass through the bird and accumulate in the litter becoming ready for reinfestation within hours[1,2,3,6,8]. The ability to infect birds within a short window is extremely advantageous, theoretically the vast majority of the birds become infected during the early development window and are fully immune around 3-4 weeks which is before the substantial growth period[2,3,6,8]. Primarily breeder pullets, turkeys, and layers benefit from vaccination due to their long rearing periods. Birds that do not acquire protective immunity to the specific strains present become susceptible to coccidiosis during fundamental periods of production. Broilers are commonly reared with antibiotic growth promoters such as ionophores in the feed as their life spans are often not long enough for a full immune system to develop[5]. During this short period of rearing, the nutrients that would normally be utilized for meat production are used to support the stimulated immune system as a result from vaccination. The use of vaccinations on broilers has increased in recent years as vaccine technology has progressed and the controversy over alternative growth promoters has expanded. Live vaccinations can be further broken down into attenuated and non-attenuated.

Attenuated vaccines are live vaccines that lack a part of the parasites life cycle. They are derived from an original strain and upon alteration lose their reproductive and pathogenic potency. Paracox and Livacox are examples of attenuated vaccines that select for Eimeria strains that have an early development when compared to their normal development. Other attenuated vaccines lose their virulence by a process of passing the parasites through embryonated hen’s eggs. An advantage of attenuated vaccines is that they have a genetically controlled stability and are less likely to induce a cocci challenge compared to non-attenuated. The period of time between infection of the host and its recovery in the feces is known as the pre-patent time. This period of time is shortened in attenuated viruses; around 13-27 hours with Paracox compared to 83+ hours for non-attenuated depending on the strains involved. Due to their low reproductive and pathogenic potency the bird may need to go through more infectious cycles before full immunity

is reach. These types of vaccinations are very common in European countries[1,2,3,6,8,9].

Non-attenuated vaccines are derived from field or laboratory strains and have not been altered in anyway. Their natural pathogenic potency stays in-tact allowing for a fully potent coccidiosis challenge to begin stimulating the immune system. Production costs are significantly less when vaccinating with non-attenuated compared to attenuated due to the low reproductive potential of the attenuated vaccines. As previously stated, in order to mount an affective immune response Eimeria spp. oocysts must reproduce in the mucosal lining of the intestinal tract. It is important to be aware of the strains in ones geographic since vaccinating with a non-attenuated vaccine comprised of strains not present could seed a farm with these species. An advantage to these unaltered vaccines is their ability to displace any local drug resistant strains that may be present. Sensitivity to the anticoccidials should be restored within 1-5 flocks after non-attenuated use; this is highly advantageous for broiler operations where coccidiosis infestation is moderate-severe and drug resistance is present. Non-attenuated vaccines cause a slower growth response around 3 weeks of age, the animal goes through compensation growth and by 35-42 days they are at the same performance level as attenuated or anticoccidial reared birds. This short window of slowed growth rate is believed to be advantageous against ascites and leg problems. Coccivac and Immucox are examples of non-attenuated vaccines; both the United States and Canada commonly use these types of live vaccines[1,2,3,6,8,9].

Vaccinated birds show a peak of oocyst build-up in the litter around 2-4 weeks during which the protective immunity is gradually built up as the infection recycles through the bird. At 4-7 weeks a higher peak has been shown to occur which represents the infection from the wild strains. This recycling period of oocysts allows for a further immunity boost ideally leaving birds fully immunized around 6-8 weeks[2,3,5,8]. The proper seeding of litter with the oocysts from vaccination is important in providing uniform immunity for the entire flock. Gas brooders have been known to kill oocysts due to the intense temperature and also encourages birds to huddle instead of evenly distribute causing oocyst seeding to be inadequate[2,3]. It is recommended that if brooding half house the birds are allowed to disperse fully around the house by day 6. If a producer desires to maintain half house brooding for longer than 4 days than the birds should be kept for at least 12 days in order to allow for a second cycle of infection to occur. The use of early developed (attenuated) strains allows for the days to be shortened to 4 and 9 due to the Eimeria spp. having already begun development prior to vaccination [2,3,8].

Regardless of attenuated or non-attenuated an ideal vaccine should compromise the following characteristics[4]:

- Induce specific immunity against economically important species of Eimeria
- Be safe for the target host species, non-target animals and humans
- Not represent an environmental hazard
- Comprise parasites of normal or low virulence, the latter trait being stable during propagations of the host

- Comprise parasites that remain viable during storage under optimal conditions for a reasonable period of time
- Protect against field strains from different geographic areas, including those where the vaccine is intended to be used
- Be administered by a commercially practical method to ensure that as many birds as possible receive a similar dose
- Have no adverse effects upon final performance or other production criteria
- Be compatible with other poultry vaccines
- Be free from viral, bacterial, mycoplasmal, fungal, and chemical contaminants
- Be cost effective when compared to other methods of coccidiosis control
- Include drug sensitive lines so they may interbreed with drug resistant field populations and thus reduce overall local resistance.

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