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Immunosuppression in Broilers

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SUMMARY

Introduction

Immunosuppression in broilers has a significant negative impact on broiler performance and economics worldwide. The key to preventing immunosuppression is reducing environmental and nutritional stress, appropriate vaccination programs and high standards of biosecurity.

What is Immunosuppression?

Immunosuppression is a syndrome not a disease and has no clinical signs. However, immunosuppression is characterized by:

- Poor performance
- Uniformity problems
- Low body-weight gain
- Increased FCR
- Frequent vaccine reactions
- Increased mortality
- Secondary bacterial infections
- Atrophy of lymphoid organs

What Causes Immunosuppression?

Immunosuppression is caused by:

- Environmental stressors
- Overstocking
- Suboptimal drinker and feeder space
- Poor nutrition
- Wet litter
- Low relative humidity
- Excess dust
- Mycotoxins
- Infectious agents, such as IBV, CIAV and Mareks

Preventing Immunosuppression

- Environment – maintain correct ventilation, good litter management, ensure a good chick start, maintaining high standards of drinker and feeder management
- Mycotoxins – complete frequent raw material testing and avoid using contaminated raw materials/feeds
- Vaccinate against CIAV and IBD
- Ensure high standards of biosecurity at all times:
  - » Minimize visitors
  - » Implement risk assessment protocols
  - » Implement farm entry protocols - showering in, changing footwear and clothing
  - » Changing footwear and sanitizing hands on entry to every farm
  - » Use dedicated equipment on a farm basis or ensure proper cleaning and disinfection of equipment and vehicles before entering the farm
  - » Have adequate down-time for cleaning out
  - » Ensure houses are wild bird and rodent proof

TAKE HOME POINTS

Maintain an environment that is appropriate for the birds throughout their life
Ensure correct ventilation is achieved
Have good litter, drinker and feeder management
Reduce nutritional stress (feed good quality feeds)
Test raw materials/feeds for mycotoxins and avoid using contaminated raw materials
Have appropriate vaccination programs in place
Maintain high standards of biosecurity at all times

Introduction

Immunosuppression, suppression of the bird's immune system, is a problem for the poultry industry worldwide. Often thought to be caused by infectious diseases such as Gumboro and mycotoxins, immunosuppression can actually be provoked by suboptimal environmental conditions, poor management practices, "overkill" vaccinations and nutritional stress, alone, or in combination with infections. The economic consequences of immunosuppression can be significant but quantifying the exact impact can be difficult. This short review will discuss the most commonly occurring forms of immunosuppression in broiler flocks and the subsequent issues that this causes for performance, and will provide practical advice on how to prevent immunosuppression and improve bird performance.

Recognizing Immunosuppression

Immunosuppression is a syndrome rather than a disease and there are no "clinical" signs. However poor performance, uniformity problems, low body-weight gain, increased FCR, frequent vaccine reactions, elevated mortality, common secondary bacterial infections and atrophy of lymphoid organs are all indicative of immunosuppression.

Causes of Immunosuppression

Environmental Stressors

Suboptimal environmental conditions increase the production of corticosterone which results in lymphoid depletion (lymphopenia) in the thymus, bursa and spleen and atrophy of the bursa and spleen. Although the exact mechanism is unclear the end result is immunosuppression.

Other environmental stressors include management issues such as overstocking, suboptimal drinker and feeder space, nutritional factors and mycotoxins. These environmental stressors can also cause dysbacteriosis, which is a negative alteration in the content of the intestinal micro flora, leading to problems with wet litter.

Wet litter is one of the main causes of foot pad dermatitis (pododermatitis), and leads to a build up of ammonia and increased humidity. Harmful gases, such as ammonia will also be increased if ventilation and the management of drinkers and litter are poor. An ammonia level of 10-20 ppm is enough to cause damage to the respiratory epithelium. The longer the exposure, the greater the damage caused to the mucociliary system.

Low relative humidity, especially in very young birds, can rapidly dehydrate the respiratory epithelium leading to ciliary damage. High relative humidity, or conditions of heat stress, can make it difficult for fast growing broilers to get rid of excess body heat resulting in panting. If birds pant they will inhale more dust and irritating gases.

Excess dust irritates the respiratory mucosa. A significant proportion of dust consists of dried feces containing many bacteria including E. coli. When this is inhaled by birds with a slightly altered respiratory mucosa the damaged cilia can't cope with the high load of dust particles and bacteria and an airsacculitis may evolve.

In some areas it is common to put birds on antibiotics for the first five days of life. However, this practice is not advised, because antibiotics given so early in life and the overuse of antibiotics will postpone the establishment of a normal gut micro flora in hatchlings. This can lead to disruptions of the normal gut micro flora in older birds, which in return can result in immunosuppression.

Mycotoxins

Mycotoxins are metabolites of the microscopic fungi commonly called molds. Molds can colonize and produce toxins (mycotoxins) on growing or harvested crops, or on stored feeds and feed ingredients. Mycotoxins, when ingested along with feed can cause metabolic and physiological disorders in poultry such as impaired tissue integrity-capillary hemorrhage and immunosuppression. Some of the most commonly seen issues caused by mycotoxins are: hepatotoxicity (aflatoxin B1), atrophy of immune organs (e.g. aflatoxin B1, ochratoxin A, T-2 toxin), suppression of cell mediated immunity (e.g. aflatoxin B1), and nephrotoxicity (e.g. ochratoxin A).

Infectious Causes

Although any infectious clinical disease can cause immunosuppression, there are certain viruses infecting and replicating in lymphoid cells that cause immunosuppression directly, often while the disease is still subclinical. Infectious Bursal Disease Virus (IBDV), Chicken Infectious Anaemia Virus (CIAV), Mareks Disease Virus (MDV) and Reovirus, while replicating in lymphoid cells cause apoptosis and cell necrosis. These viruses change the regulation of immune response by generating "suppressor" macrophages, which suppress T lymphocyte blastogenesis.

Infectious Bursal Disease Virus (IBDV)
IBDV belongs to the Avibirnaviridae genus. There are two serotypes but only serotype one causes immunosuppression and clinical disease (Gumboro Disease) in chickens. It has long been known that IBDV can cause severe immunosuppression with impaired antibody response and high susceptibility to secondary diseases particularly when chicks get infected before three weeks of age. The molecular basis of IBDV induced immunosuppression is the result of multiple interactions between different viral proteins (VP's) and infected B cells. In cells in which IBDV replicates, death is caused by apoptosis induced by VP2 and VP5. The mechanism by which these proteins interact with the apoptotic pathways is still not clear.

Chicken Infectious Anemia Virus (CIAV)
CIAV is a Gyrovirus belonging to the Circoviridae family. CIAV is extremely resistant to disinfectants and can withstand temperatures of 80°C (174°F) for 15 minutes. In young chickens CIAV impairs the thymus, affecting immunity and causing major economic losses in broiler production. The infection occurs naturally when breeder flocks, just before or during egg production, with no previous exposure to the virus become infected. Under these conditions, CIAV is transmitted vertically to the progeny, which develop the disease symptoms, including thymus atrophy, hemorrhages and "blue wing disease", from 10-14 days of age. CIAV can also spread horizontally in a contaminated environment to broiler progeny of immune broiler breeders. Both clinical and subclinical CIAV infections have a substantial effect on commercial broiler performance and profitability. Secondary infections also play a role in outbreaks of CIAV increasing the losses.

Marek's Disease Virus (MDV)
MDV is an Alphaherpesvirus causing tumors of T cells in chickens. Since the identification of this virus in the 1970's, very virulent and very virulent plus strains have evolved. Usually the tumors associated with Marek's are not seen in broiler chickens. MDV can cause an early immunosuppression characterized by cytolysis and a late immunosuppression at the reactivation of the virus with tumor formation (adult birds). The early immunosuppression is characterized by destruction of lymphocytes (B and T cell depletion) in lymphoid organs during the first two weeks of infection, resulting in marked atrophy of the bursa and thymus. Depending on the virulence of the virus the atrophy can be irreversible or transient.

Prevention of Immunosuppression

Environment
The quality of the environment has an important role in maintaining bird health and welfare, preventing immunosuppression and finally achieving good performance with increased profit.

It is essential to deliver a constant and uniform supply of good quality air to birds with no drafts. Fresh air is required at all stages of growth to allow the bird to remain in good health and achieve full potential. Proper ventilation can only be achieved if the house and therefore the ventilation equipment have the proper number and capacity of fans, cooling pads and air inlets. These should be optimized for the local climate and the operation of these should take into account the season and the time of the day. Another key element of proper ventilation is having the knowledge to operate and maintain the ventilation equipment.

Litter management, although a key management aspect of broiler husbandry, is also one of the most neglected. The use of an 8-10 cm (3-4 in) thick layer of clean, dry and absorbent litter material is critical in maintaining good litter quality. This can be wood shavings (better than straw) or chopped straw. Preheating the floor helps remove floor condensation. A floor temperature of 28-30°C (82-86°F) at placement should be achieved. Management areas that will help maintain the litter in good condition are a good chick start; high standards of water management with non-leaking drinker lines; measuring daily consumption; measuring and adjusting flow rates to avoid nipple lines leaking; regularly cleaning water lines and water sanitization by for example chlorination and good ventilation management.

Prevention of Mycotoxins
Frequent raw material testing for the most commonly occurring mycotoxins is essential to know the mycotoxin status of raw materials. If no specialized labs are available offering HPLC (High-Performance Liquid Chromatography) tests, the use of commercially available ELISA kits can help. Avoid using raw materials contaminated with mycotoxins for producing poultry feeds. Use commercially available toxin binders to lower the risk. Avoid using breeder feeds which are contaminated with high levels of mycotoxins or dilute them with non-contaminated feed and use to feed broilers towards the end of the grow-out.

Vaccinate Broiler Breeders Against CIAV

All broiler breeders should be vaccinated against CIAV with a single dose of a live vaccine during the rearing period. It is important to achieve uniform sero-conversion before the onset of lay.

Vaccinate Broiler Breeders Against IBDV

Broiler breeders should be hyper-immunized with appropriate vaccination schemes for IBDV. Hyper-immunization is achieved by priming parent stock in rear with live IBDV vaccines, followed by inactivated IBDV vaccines at the end of the rearing period and if necessary during lay. Treatment of parent stock in this way is necessary to ensure that day-old broiler chicks receive a high and uniform level of maternal antibodies (MAB) for IBDV. Levels of IBDV MABs in progeny decline as the parent flock ages, but the level of MABs necessary to neutralize IBDV varies with the invasiveness and pathogenicity of the field virus.

MABs are efficient neutralizers of IBDV, but can also inactivate some vaccine strains. This effect varies according to the residual virulence of the vaccine strain involved.

It is mostly live vaccines that are used in broilers for active Gumboro protection. Vaccination using intermediate or intermediate plus strains can occur on farm via the drinking water. The disadvantage of live IBDV vaccines is inherent pathogenicity, particularly that of intermediate plus and hot vaccines. Immune-complex vaccines and vectored vaccines can be used as alternatives to live vaccines.

The timing of vaccination can be challenging. The use of vaccination timing formulas will help to ensure that vaccination is timed to prevent vaccination neutralization by MABs and to prevent levels of MABs running low prior to vaccination. Vaccination timing formulas are based on initial maternal antibodies and the rate of decline and can help to improve the vaccinal protection. Finally, in areas (e.g. North America) with variant type IBDV's a different approach with variant vaccines strains might be necessary.

Biosecurity

Biosecurity is the prevention or control of contact of pathogens with animal populations. The broad aim of biosecurity is to keep the birds free from infection. If this is impossible there may still be advantages in decreasing or delaying the challenge. For example, cleanout will remove coccidial oocysts, vaccination may be more effective against lower challenges and MDV challenge may not be prevented but can be delayed.

When planning new facilities, the location of the farm, and the farm and house design, are of major importance and will have a significant bearing on bird health, disease status and production performance. Distance is the most practical biosecurity measure preventing the transmission of air-borne infections. However, the movement of feed trucks, chick trucks and people between farms represents a significant biosecurity risk and should be carefully monitored.

Biosecurity should be an integral part of daily routine husbandry and the management and staff should be committed to a biosecurity program which should be mandatory from the "top" to the "bottom" of the organization.

Basic biosecurity procedures include:

- Minimizing visitors.
- Implementing risk assessment protocols for visitors.
- Farm entry protocols including showering in and out.
- Changing of clothing and footwear.
- Changing of footwear at the entrance to every house.
- Sanitizing hands on entry to every house.
- Using fumigation cabinets for mobile phones, writing pads etc at the farm entrance to minimize contamination.
- Using dedicated equipment on a farm basis, or proper cleaning and disinfection of equipment and sanitization of vehicles before entering the farm to prevent cross-contamination.

"All in – All out" principles should be adopted, which means that for a small part of each cycle the whole farm is empty. The site should be used for one purpose only, e.g. for growing broilers. Single age sites and "all in – all out" procedures will help to stop the build up of pathogenic microorganisms for subsequent flocks – e.g. Reovirus, Rotavirus and IBDV.

The period during each cycle when the farm is empty should be used for a thorough cleanout. With an adequate down-time – a minimum of 12-14 days – the carryover of pathogens can be reduced. When a poultry farm is depopulated, all manure should be removed from the houses and disposed of safely, away from the site (at least two km from the farm).

Effective cleaning and disinfection procedures should then be applied. Poultry houses should be washed out using (preferably hot) water at high pressure (35–55 Bar, 510-800 psi) to ensure the removal of all organic material. The use of detergents will assist the cleaning process. Suitable disinfectants will reduce the infectivity of any remaining virus particles. Always apply

disinfectants at the advised concentrations and make sure the recommended contact times are kept.

Generally products containing formaldehyde, glutaraldehyde, iodophores, chlorine-releasing agents or quaternary ammonium compounds are suitable. Clean, remove scale and disinfect drinkers and water lines after each cycle using appropriate chemicals. If bore holes are used water should be chlorinated.

It is necessary to prevent rodents and wild birds from entering the poultry house because they act as biological or mechanical vectors for a wide variety of poultry diseases and zoonoses. Poultry houses need to be rodent and wild bird proofed while the surrounding area needs to be kept tidy, the vegetation cut short and nesting sites eliminated.

The use of bait stations along the outside walls, under feed bins and at entrances contributes to rodent control and allows the rodent population to be monitored. Darkling beetles can also carry diseases (e.g. IBDV, MDV, Salmonella), damage the insulation of the house and eat chicken feed. Therefore, effective chemicals should be used between flocks to prevent darkling beetle infestation. Flies and other flying insects have also been proven to be carriers of disease and therefore it is essential to eliminate or minimize their numbers in the poultry houses.

Dead birds should be collected daily and disposed of safely and hygienically without contaminating the environment of the farm and offering food source to rodents, insects and other wild animals. One of the favored methods of dead bird disposal is incineration.

Biosecurity can form the basis of a sustainable production system but may require fundamental changes to the farming base and staff practices to implement effectively.

Conclusions

Immunosuppression can result in a significant loss of production and economic performance. Immunosuppression is caused by suboptimal environmental conditions, poor management practices, and nutritional stress as well as infectious diseases. The key to preventing immunosuppression is maintaining appropriate environmental conditions and vaccination programs, reducing nutritional stress and maintaining high standards of biosecurity at all times. With correct procedures in place immunosuppression should be minimized, if not eradicated, and broiler performance and profitability will be improved.

Key Points for Preventing Immunosuppression:

- Maintain an environment that is appropriate for the birds.
- Ensure correct ventilation is achieved.
- Have good litter management – litter depth should be 8-10 cm (3-4 in) and floor temperatures 28-30°C (82-86°F) at placement.
- Maintain good drinker line management – measure water intake and flow rates, have in place a good sanitation program.
- Test feed/raw materials for mycotoxins.
- Have appropriate vaccination programs in place.
- Maintain high standards of biosecurity.
- Establish a principle of “all in-all out”.
- Reduce between farm cross-contamination by having appropriate disinfection procedures in place.
- Ensure poultry houses are vermin (rodent and wild bird) proofed.

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