Effective vaccination in broilers to maintain flock health and productivity

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Vaccination is standard practice in poultry production worldwide, with producers relying heavily on its success to control established and emerging diseases, especially in areas where biosecurity is an issue. Successful immunity, including response to vaccines, is dictated by various factors, including the physiological status of the bird, age (as some vaccines are age dependent), water quality, poor immunity transfer in ovo and exposure to toxins or infections.

The bird needs to be in a state whereby its immune system is active and able to make best use of the vaccine to establish good protection against the target disease.

Intensively farmed broilers can have poor immune responses or even immune depression due to their environment, so ensuring these factors are addressed is key to flock health and performance.

Specialist feed ingredients

Immunity can be improved by the use of specialised prebiotics, mannan oligosaccharides (MOS), which bind pathogens in the gut and 'present' them to the M cells embedded in the gut wall. These cells are responsible for assessing any potential disease threat entering the animal and initiate reactions to launch an immune response.

In addition, mannose can bind to the gut wall via receptors, where it activates macrophages and releases cytokines directly via cascade reactions.

Research has shown that such interactions are involved in the promotion of signalling cascade reactions, which are important for the multiplication of immune cells and components during challenges. In experiments where sheep red blood cells were injected, birds fed diets containing MOS had higher antibody titres the following week, an effect which persisted for four weeks.

Trials conducted in Ross broiler chickens treated with Newcastle and infectious bursal disease (IBD) vaccines at 15 and 33 days of age via the ocular conjunctive route compared immune responses at 21 and 48 days of age in birds fed either an unsupplemented corn-soy based diet, or the same feed supplemented with 1kg/t MOS from eight days old.

Antibodies to the vaccine were measured by ELISA and IHA (BIA-Test kit, Romvac Co). Birds receiving MOS had significantly higher antibody titres to vaccination at 21 days (P=0.044) with IHA analysis, and at 48 days (P=0.045 and 0.009 respectively for ELISA and IHA).

Responses to the vaccination were 128% higher at 21 days of age and approximately doubled at 48 days of age (Table 1). Research data such as this have helped elucidate the mode of action of MOS and its fractions.

Novel products such as Actigen (Alltech), a mannan rich, specialist fraction of MOS, have been developed specifically to support intestinal health via its ability to bind pathogens and interact with the immune system. Actigen is specifically developed for use in animal feed, whereby its form and dose (200-800g/t) are relevant for inclusion in diet formulations.

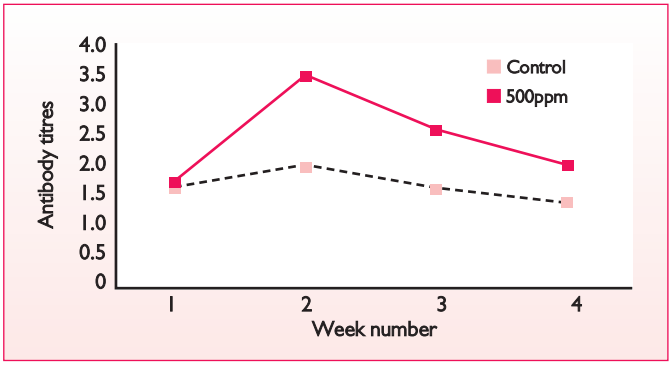

Fig. 1. Effect of feeding 500ppm MOS on antibody response to injected sheep red blood cells (Lilburn and Cotter, 2000).

Nutrigenomics, the scientific discipline which utilises new technology to investigate the interaction between feed and genetics, has revealed that Actigen has an impact on gene expression. Research has shown that various immune parameters that indicate health status of the birds are changed, for example reduced TLR4 (a major signalling component) in caecal tonsils.

Upregulation of genes for toll-like receptor 3 (TLR3), myxovirus resistance 1 (MX1), interferon regulatory factor 7 (IRF7), suppressor of cytokine signalling 1 (SOCS1) and down-regulation of ADP-ribosyltransferase (CHAT2) further demonstrate that Actigen modulates the intestinal immune system. These impacts on immunity are all tied to the improvements in vaccination responses seen in birds fed Actigen.

Other feed-related factors

Other feed-based factors can influence the success of vaccination, which are mycotoxins (from fungal contamination) in feed and correct supplementation of selenium (Se) in the diet. These affect the level of oxidising free radicals in the body, which can disrupt the functioning of the immune systems and the effectiveness of vaccination, but in different directions.

Mycotoxins cause increased oxidative load in tissues and cells, whereas Se is a crucial antioxidant mineral needed in enzymes which protect and repair cells and tissues.

Mycotoxins

Mycotoxins are produced from fungi that infect feed materials which have been poorly stored or after wet or late harvests. The immunosuppressive effects of consumed mycotoxins are well documented. Data from broiler studies have shown reduced immuno-competence and poorer vaccination responses when the birds were fed contaminated feed.

For example, Fusarium toxins are known to adversely affect immune responses in poultry.

Javed et al. (1995) studied Fusarium contamination in 1-35 day old vaccinated broilers and analysis of blood samples showed a decrease in white blood cells and reduced titres to Newcastle disease virus. Aflatoxin exposure from contaminated diets fed to 42 day old broilers caused significantly lower antibody titres. This demonstrated a reduction in the immune response to pathogens, either from invading organisms or vaccination. Using feed materials naturally contaminated with several types of Fusarium which were fed to broilers from day old

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Table 1. Immune response to vaccination in broilers supplemented with MOS.

Diet	Vaccine	Method	Titre 21 days	Titre 48 days
Control	NewVac	ELISA-ND	493	671[a]
Mos 1 (kg/t)	NewVac	ELISA-ND	270	1568[b]
Control	NewVac	IHA-ND	59.6[a]	218.9[a]
Mos 1 (kg/t)	NewVac	IHA-ND	76.4[b]	404.0[b]

Means not sharing a letter differ significantly P<0.05

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for 56 days, caused significant reductions in antibodies (IgA). IgA is the first line of defence against environmental pathogens in exposed mucosal surfaces, for example the respiratory tract, which is particularly important in intensively housed poultry.

Kamalavenkatesh et al. (2005) investigated the impact of T2 and CPA toxins on antibody titres to Newcastle disease and showed that these toxins, consumed either singly or in combination, had an immunosuppressive impact on 1-28 day old vaccinated broilers to Newcastle disease.

Selenium and antioxidation

Susceptibility to disease in Se deficient or marginally deficient livestock is well documented. Low Se can reduce cell mediated immune responses, and in the British Nutrition Foundation's briefing paper (2001), the importance of Se for immunity is discussed in detail.

Certain 'killer' immune cells (macrophages) utilise oxidising reactive oxygen species (ROS) for destroying pathogens and so there is a need to maintain levels of antioxidants to remove the ROS which have been employed by the immune system before they can damage other cells and tissues in the host. Se influences both the innate, non-adaptive system, which is functioning at hatch and the acquired (adaptive) immune systems, which develops later on as a response to exposure to pathogens. The innate immune system employs various factors, including barriers to infection (mucous secretion), antibodies (immunoglobulin) and macrophages. Both T and B lymphocytes are parts of the acquired system that mature with exposure to immune challenges, which includes vaccination.

The efficiency of antibody production to any threats is affected by Se availability; for example, IgM, IgG, IgA and IgG and IgM titres are reduced if Se is too low. Trials with chickens reported by Leng et al. (2003) showed significant increases in immune cell expression when the birds were supplemented with organic selenium (Table 2).

Diet	CD3 49 days	CD4 28 days	CD8 49 days	Titre 48 days
Control (no added Se)	2440	8.5	920	671[a]
Inorganic Se (0.2ppm)	3300	11	1050	1568[b]
Organic Se (0.2ppm)	3300	12.5	1180	218.9[a]
Organic Se (0.7ppm)	3360	13.6*	1250*	404.0[b]

* denotes means to be significantly different from control diet (P<0.05)

Table 2. Levels of CD immune cell expression (mm²) in caecal tonsils (CD3), bursa of Fabricius (CD4) and duodenum (CD8) in growing chickens (Leng et al., 2003).

As vaccination stimulates the immune system to produce antibodies towards a specific pathogen, this is why Se-deficient or marginal animals show poorer responses acquiring immunity as they age.

This a particular issue for vaccines that are given via the nose or eyes, which is common in poultry, as these affect the production of IgA, the main mucosal immune defence system, and so fast and efficient IgA production following vaccination is essential to protection.

Feeding supplemental organic Se to breeder hens is known to increase Se in the egg, giving the hatchling chick more access to this important antioxidant mineral from the start.

Yang et al. (2000) reported that receiving appropriate Se in feed had an increased antibody titre against Newcastle disease after being vaccinated at three and 21 days of age due to the stimulation of antibody production.

Effective vaccination

Vaccination is of key importance in maintaining health and productivity in flocks of growing chickens, especially those reared using intensive management systems. However, several feed-related factors can influence vaccination success.

Specialist MOS feed ingredients are known to be active on various levels in health, by interacting with pathogens in the gut and promoting immunity either directly or via improved vaccination efficiency.

Mycotoxins must be combated by appropriate use of proven binders, which are suitable for in-feed use, such as Mycosorb (Alltech).

Se, as a key antioxidant mineral, is important to work in concert with the immune system, where it clears up excess ROS used by 'killer' cells, and to promote correct immune development, whether via exposure to disease or vaccination. ■

References are available on request from the author