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Research Update

Chickens: Effects of feed supplementation on immune response to Newcastle vaccination

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Published studies demonstrate that feeding Diamond V Original XPC™ (XPC) has a beneficial impact on both the innate and adaptive immune response (Jensen et al., 2008; Moyad et al., 2009). The innate portion of the immune system serves as the first line of defense against challenges using relatively non-specific mechanisms, while the adaptive side defends the host using highly specific mechanisms.

These mechanisms protect the intestinal wall and respiratory barrier while also protecting against systemic spread of the pathogen.

The effects of feeding XPC on vaccine titers have been reported in several broiler studies (Al-Homidan and Fahmy, 2007; Gao et al., 2008; Fathi et al., 2012). In each instance, an improvement in vaccine titers was observed when birds were fed XPC, suggesting enhanced antibody production and potential increased protection against disease. The mechanism for increased antibody titers, a function of the adaptive immune system, has not been clearly defined.

Recent research has shown increased antibody titers and flow cytometric results to indicate XPC supplementation optimizes the immune response of birds (McIntyre and Carey, 2014). The information reported here is a continuation of that project, which was designed to improve our understanding of XPC's influence on the bird's adaptive immune system.

Experimental design
One-day-old Ross broiler chicks (n = 120) were divided into 2 feed treatments:

- T1 -- Control diet
- T2 -- Control diet plus XPC (2.5 lb/ton)

Birds were grown at the Texas A&M University (TAMU) poultry research center. Standard broiler diets (Starter, Grower, and Finisher) and water were provided *ad libitum* to birds housed in floor pens from 0 to 42d of age.

Primary immune challenge
At 1d of age (prior to placement into pens), all chicks in both treatments were vaccinated with B1 Newcastle disease vaccine (NDV), followed by B1, Lasota NDV at 21d. All birds were vaccinated individually via nasal administration.

Sample collection
Spleen, thymus, and bursa tissue samples were collected from birds of each treatment (n = 15) at 14, 21, 28, and 42d and weighed. From each organ, one half was stored in a nuclease-neutralizing "fixative" (RNA*later*) for gene expression profiling, while the other half was put on dry ice for cryosectioning and histological analysis. Spleen, thymus, and bursa of Fabricius indices (defined as organ weight/body weight ratio) were determined. Blood samples were collected from the same 15 birds per treatment. Antibody titers and flow cytometric results were detailed in the previous report (McIntyre and Carey, 2014).

Gene expression profiling
The effect of supplemental XPC on expression profiles (mRNA concentrations) of genes that play pivotal roles in adaptive immunity were evaluated in spleen on 14 and 28 days of age. In total, 84 genes were tested using a Qiagen RT Profiler™ PCR Array (Qiagen, Valencia, CA).

Results
The host innate immune response to viral infection is an immediate reaction, designed to slow virus growth and help the host develop specific protection through the adaptive immune responses. The spleen is the lymphoid organ that becomes infected early in the process. A cascade of cellular interactions takes place in the spleen, ultimately leading to pathogen-specific B and T cells.

At 14 days of age (13d post primary immunization), the PCR array identified numerous genes that were significantly ($P < 0.05$) induced or repressed by at least two-fold in the spleen. Gene expression is expressed as fold regulation (XPC over control). Effects on immune-associated genes showed important aspects of the birds' immune systems (Table 1).

Table 1. Immune associated genes: Fold differential regulation (XPC supplemented over control) in broiler spleen at 14 days of age.

System	Gene*	Fold Increase	Activity
Cytokines	INFA3	3.13	Anti-viral
	INFB	2.74	Anti-viral
Receptor	TLR3	2.23	Antigen recognition
T-helper	INFG	3.09	Macrophage activation
	IL2	2.45	NK and B cell activation
	STAT4	2.37	T cell growth

*Gene identification per Qiagen RT Profiler™ PCR Array.

In the previous report (McIntyre and Carey, 2014), ELISA data showed XPC-supplemented birds had significantly higher titers at day 28, suggesting that gene expression changes in the XPC birds happened earlier than 7 days after the boost. Future studies will investigate how rapidly birds respond following vaccination.

Immune organ development

The central immune organ indices (thymus and bursa) in the XPC treatment group peaked at 14d (Figures 1 and 2). In contrast, the peak in the control group was observed at 28d in thymus and 21d in bursa (1 to 2 weeks later). This observation suggests that XPC supplementation promotes early development of the central immune organs, an effect that may be observable earlier than 14d post-hatch.

Figure 1. Thymus weight index

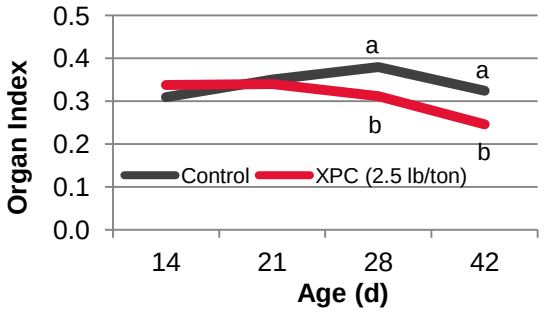
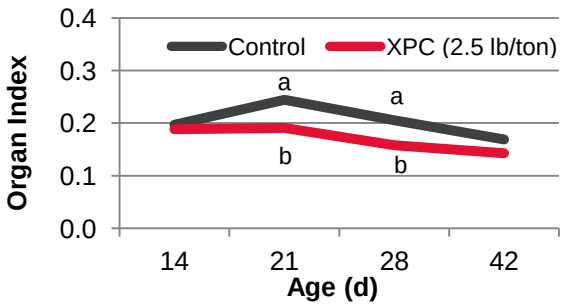


Figure 2. Bursa weight index



[a,b] Values with different letters are significantly different ($P < 0.05$).

Conclusions

- Genes associated with anti-viral activities and the T_h1 immune response (cell-mediated immunity) were significantly up-regulated in the Original XPC group compared to the controls.
- Original XPC supplementation may promote early development of the central immune organs.

References

Al-Homidan, A. and M.O. Fahmy. 2007. The effect of dried yeast (*Saccharomyces cerevisiae*) supplementation on growth performance, carcass chemical analysis, immunity, ileum villi heights and bacterial counts of broiler chickens. Egypt Poult. Sci. 27:613-623

Fathi, M.M., S. Al-Mansour, I. Al-Homidan, A. Al-Khalaf. 2012. Effect of yeast culture supplementation on carcass yield and humoral immune response of broiler chicks. Vet. World 5:651-657

Gao, J., H.J. Zhang, S.H. Yu, S.G. Wu, I. Yoon, J. Quigley, Y.P. Gao, and G.H. Qi. 2008. Effects of yeast culture in broiler diets on performance and immune-modulatory functions. Poult. Sci. 87:1377-1384

Jensen, G.S., K.A. Redman, K.F. Benson, S.G. Carter, M.A. Mitzner, S. Reeves and L. Robinson. 2008. Antioxidant Bioavailability and Rapid Immune Modulating Effects After Consumption of a Single Acute Dose of a High-Metabolite Yeast Immunogen: Results of a Placebo-Controlled Double-Blinded Crossover Pilot Study. J. Med Food 14:1-9

Moyad, M.A., L.E. Robinson, J.M. Kittelsrud, S.G. Reeves, S.E. Weaver, A.I. Guzman, and M.E. Bubak. 2009. Immunogenic yeast based fermentation product reduces allergic rhinitis-induced nasal congestion: a randomized, double-blind, placebo controlled trial. Advances in Therapy 26:795-804.

McIntyre, D. and J. Carey, 2014. Chickens: Feed supplementation to affect the rate and level of immune response. PoultryAdvisor, November 2014.

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