Expression of EIF2 Family Genes under Newcastle Disease Virus Infection in Two Chicken Lines

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Summary and Implications

Newcastle Disease Virus (NDV) causes large economic losses around the world and recent outbreaks have occurred in the US. We assessed the expression of eukaryotic translation initiation factor 2 (*eIF2*)-related genes in the spleens of two genetically different, inbred chicken lines from the Iowa State University Poultry Genetics program. Of the two lines, Fayoumis are relatively resistant and Leghorns are relatively susceptible to NDV. We found that challenged Fayoumis had lower expression of genes encoding the eIF2 and eIF2B subunits than challenged Leghorns. These differences in expression of eIF2-related genes may contribute to the differential genetic resistance of these chicken lines to NDV. Our results suggest that the eIF2 family should be the focus of further studies to define host genetic resistance to NDV. Application of information about disease-resistance mechanisms under genetic control may lead to future genetic improvements of poultry populations for resistance to Newcastle disease, or more efficacious vaccine development.

Introduction

A major long-term goal of genetic studies is to determine what makes birds more resistant to pathogens and to use this information to reduce the negative impacts of disease on poultry health and the economics of the poultry industry.

The pathology caused by NDV infection is determined by several factors including the level of host bird's genetic resistance to the virus. Inside the infected host, NDV depends upon the host cells' translation machinery to replicate. Host cells can therefore regulate protein synthesis to control viral replication. The eukaryotic translation initiation factor 2 (*eIF2*) family acts in the first stage of protein translation and plays an important role in its regulation. In our study, we evaluated the expression *eIF2* family-related genes in two different chicken genetic lines. The lines, Leghorn and Fayoumi, are relatively susceptible and resistant to NDV, respectively. We have used them as a discovery platform to characterize genetic elements controlling immune response to NDV. We hypothesize that the lines differentially regulate the expression of genes related to host protein synthesis as a defense mechanism in response to NDV infection, and that this genetic control may contribute to the level of host resistance to NDV.

Materials and Methods

The effect of NDV challenge on gene expression in the spleen of the Fayoumis and the Leghorns at two- and six-days post infection (dpi) was evaluated. Chickens from both lines were either challenged with a concentrated NDV vaccine strain via the eyes and nostrils or non-challenged (control). The chickens from both lines and challenge statuses (NDV challenged or control) were euthanized at 2- or 6-dpi for spleen harvest. The RNA was isolated from spleen samples and used to assess the expression of seven genes related to the eIF2 family using quantitative PCR. The expression of each gene was analyzed by pairwise comparisons of lines and treatment groups using Student's t test in JMP 14.1.0 software (SAS Institute, 2018).

Results and Discussion

To determine the effect of chicken genetic lines, the gene expression by line was contrasted within each treatment group (NDV challenged or control). For the non-challenged control birds, Fayoumis had higher expression of *EIF2S1* and *EIF2S2* at 2 dpi (P <0.05) compared to Leghorns (Figure 1).

In contrasting the genetic lines within the NDV challenged chicken treatment at 6 dpi, however, a different pattern was observed. The Fayoumis had lower expression of *EIF2S1*, *EIF2S2*, *EIF2S3* and *EIF2B4* compared to the Leghorn chickens (P <0.05, Figure 2). No significant differences for these genes were observed between lines within control group at 6 dpi or within challenged group at 2 dpi.

Comparing each line within treatment group, Fayoumis that were NDV challenged had lower expression of *EIF2S1*, *EIF2S2* and *EIF2B5* genes than nonchallenged control Fayoumis at 2 dpi (P <0.05). There was no effect of NDV challenge on the expression of any gene from eIF2 family for Leghorn chickens.

Our data suggest that genes from the eIF2 family may contribute to some of the differential response to NDV that exists between the Fayoumi and Leghorn chicken lines. We hypothesize that the Fayoumis are more resistant to the NDV challenge than the Leghorns due in part to differences in the expression of *eIF2* and *eIF2B* genes, which can regulate host protein synthesis and thereby reduce viral replication.

Acknowledgements

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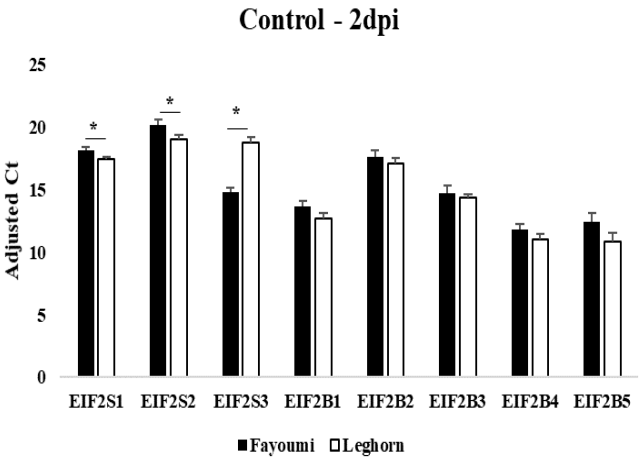

Figure 1: Gene expression at 2 dpi in the spleen of control, non-challenged Fayoumi and Leghorn chickens. Gene expression level is presented as the adjusted cycle threshold (Ct). *EIF2S1*, *EIF2S2* and *EIF2S3*, eukaryotic translation initiation factor 2 subunit alpha, beta and gamma; *EIF2B1*, *EIF2B2*, *EIF2B3*, *EIF2B4*, and *EIF2B5*, eukaryotic translation initiation factor 2B subunit alpha, beta, gamma, delta and epsilon. **P* <0.05

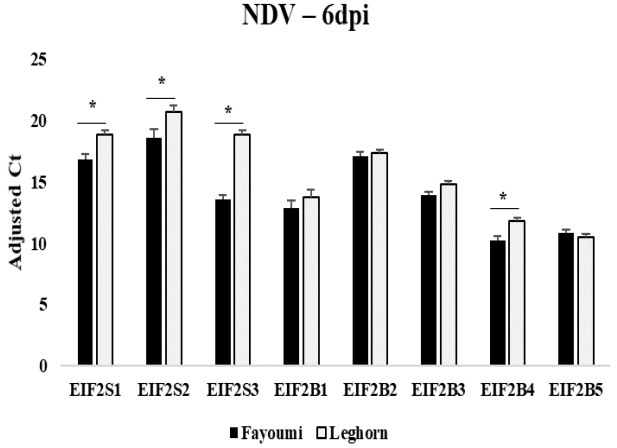

Figure 2: Gene expression at 6 dpi in the spleen of NDV-challenged Fayoumi and Leghorn chickens. Gene expression level is presented as the adjusted cycle threshold (Ct). *EIF2S1*, *EIF2S2* and *EIF2S3*, eukaryotic translation initiation factor 2 subunit alpha, beta and gamma; *EIF2B1*, *EIF2B2*, *EIF2B3*, *EIF2B4*, and *EIF2B5*, eukaryotic translation initiation factor 2B subunit alpha, beta, gamma, delta and epsilon. **P* <0.05