Simulated Bacterial Infection in Three Diverse Lines of Chickens Causes Differing Immune Responses: Changes in Body Temperature and Gene Expression Levels

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Summary and Implications

Three genetically distinct lines of chickens were subjected to a simulated bacterial infection. The immune response of the different types of chickens were compared to provide insights into cellular mechanisms underlying immune response to pathogens. The three lines responded differently to the challenge through inflammatory response and gene expression. The inflammatory response was defined by body temperature measurements.

Commercial animal agriculture is experiencing a strong consumer preference for meat produced without the use of prophylactic antibiotics. Identifying genetic differences between birds responding favorably versus unfavorably to infection could provide us with powerful information. This knowledge could then be applied to commercial breeding stock as a selection tool for producing chickens with better immune responses to bacterial infections and subsequently reduce antibiotic use.

Introduction

Two major bacterial challenges in commercial poultry are *Escherichia Coli* and *Salmonella ssp*. These two bacteria have a common component in their cell walls – lipopolysaccharide (LPS). The chicken's immune system can recognize the presence of these types of bacteria through LPS. Therefore, injection of LPS is a popular method of experimentally inducing an immune response in chickens without actually infecting the birds with bacteria. Immune response to bacterial infections can be studied this way.

Materials and Methods

Three genetically different lines of chickens were used in this study (broiler, Fayoumi, and Leghorn). Six of each type were injected with LPS and six were given a mock saline (PBS) injection as a control. Blood was collected from all birds 1 and 3 hours post-injection, and the white blood cells isolated. RNA was extracted from the white blood cells and used to measure the amount of specific immune response related genes being expressed after injection.

Body temperatures were recorded at 0, 1, 2, 3, 5, and 7 hours post-injection and used to quantify inflammatory response.

Results and Discussions

Differences in body temperature were found between birds receiving LPS versus saline and between the different lines of chickens (Table1, Figure1). Differences between LPS and control groups indicate that indeed an immune response to LPS occurred. These results also provide evidence that the diverse genetic backgrounds of the chickens affected their immune response to bacteria.

Expression levels of two immune response related genes were measured – Interleukin-1β and TNF-Like Ligand 1A. Differences in IL-1β gene levels between the three lines and LPS/saline groups were discovered (Figure 2). Birds receiving LPS injection had significantly lower levels of IL-1β than the control group. These differences implicate IL-1β in the response to bacterial infection. Results for TL1A were not as clear.

Overall, Fayoumi chickens exhibited superior immune function through increased inflammatory response to a simulated bacterial infection and serve as a good model for studying poultry immunology. IL-1β expression levels were different between broiler chickens and the other two lines, warranting further investigation into the functions of this gene.

Acknowledgments

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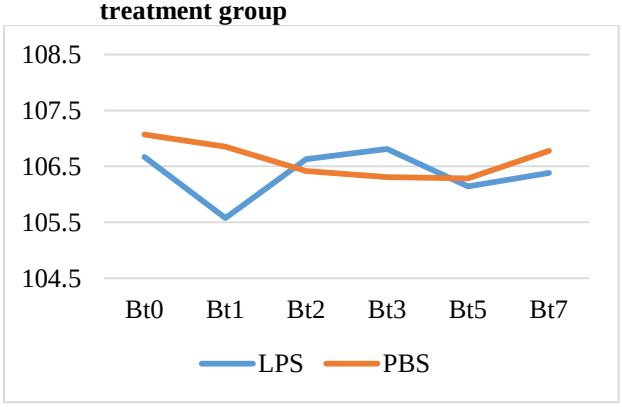
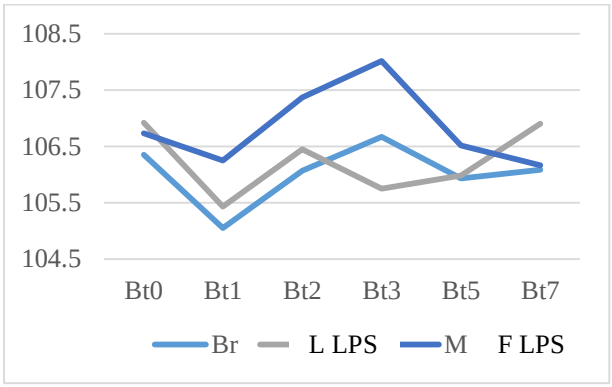
Figure 1. Average body temperature over time post-stimulation, by line and treatment group*.

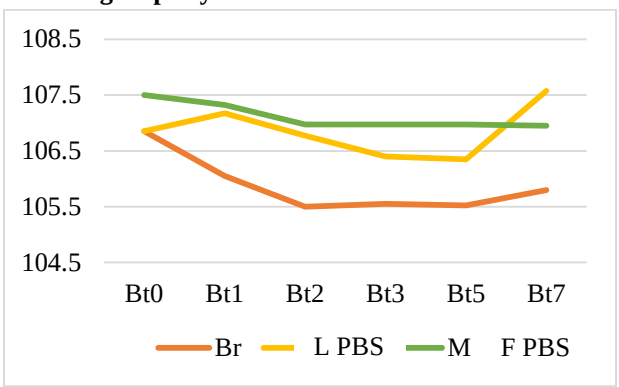
a) Average body temperature of all birds by treatment group



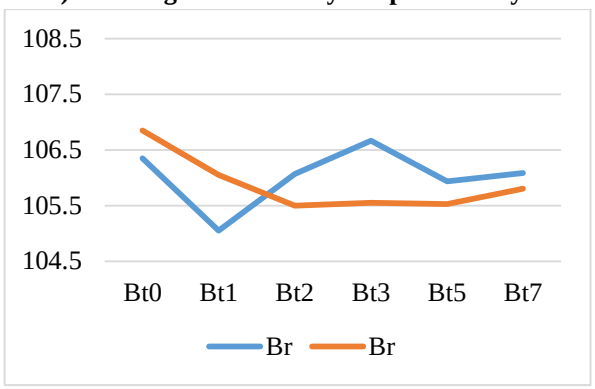
b) Average body temperature of LPS treatment groups by lines



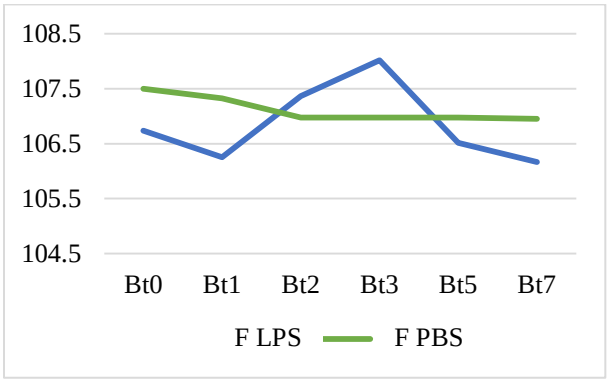
c) Average body temperature of PBS treatment groups by lines



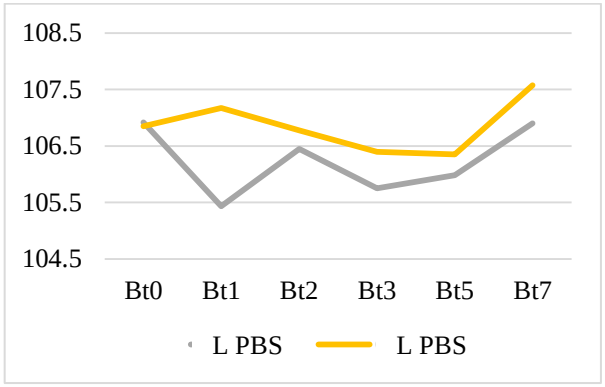
d) Average Broiler body temperature by treatment



e) Average Fayoumi body temperature by treatment group



f) Average Leghorn body temperature by treatment group



* Br – broiler; L – Leghorn; F – Fayoumi; PBS – mock saline injection; LPS – simulated bacterial injection; Bt0 – body temperature at time of injection; Bt1 – body temperature 1 hour post injection

Figure 2. Expression of IL-1B across treatment groups and lines

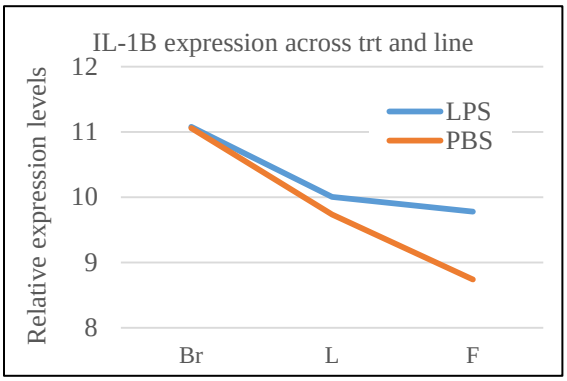


Table 1. Body temperature analysis (P values)

Hour	Line	Trt
0	0.0164 Br^{a} F^{b} L^{ab}	0.004
1	<0.0001 Br^{a} F^{b} L^{c}	<0.0001
2	<0.0001 Br^{a} F^{b} L^{c}	0.4729
3	<0.0001 Br^{a} F^{b} L^{a}	0.0011
5	<0.0001 Br^{a} F^{b} L^{c}	0.0326
7	<0.0001 Br^{a} F^{b} L^{c}	<0.0001

Br – broiler; L – Leghorn; F – Fayoumi; a,b,c Lines not sharing a superscript are significantly different. $P < 0.05$ are significant differences.