

**Doctoral Thesis**

**Studies on the innate immune function and its response to probiotics treatment  
in the intestine of broiler chicks**

(Summary)

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The inflammation by pathogenic bacteria, such as *Salmonella* spp., causes the serious demerger for chicken meat and eggs productions. Specially, the intestinal tract which contains the microbiota complex has risks of the infections by pathogenic bacteria. The innate immunity plays important roles in the immunodefense against the infection by pathogenic bacteria in younger chick before adaptive immune system develops. Antimicrobial peptides (AMPs) have a broad spectrum of antimicrobial activity. Thus, the enhancement of the innate immune system including AMPs synthesis in the chick intestine is important for the safe chick breeding. Antibiotics treatment had been used as growth promoter, but it has a risk of appearance of resistant bacteria which is the serious problem for the public health. Probiotic treatment is expected to improve growth-performance by modification of the luminal microbiota and metabolome in intestine. Since probiotics treatments are also expected to enhance the intestinal immunodefense functions in the intestine, probiotics may be useful for the safe chick production instead of antibiotics. Thus, the aim of this study was to determine the expression profiles of innate immune molecules in the chick intestine and whether intestinal microbe and probiotics enhanced their expressions.

### ***The expression profiles of avian $\beta$ -defensins (AvBDs) and pro-inflammatory cytokines in the chick intestine***

Avian  $\beta$ -defensins (AvBDs) and proinflammatory cytokines play important roles for innate immune response. However, the expression profiles of these innate immune molecules in the intestine during the growth of chick are not well studied. Thus, it was examined that changing on the gene expression levels of AvBDs and proinflammatory cytokines and the localization of AvBD2 in the chick intestine.

### ***Chapter 3. The immune response of avian $\beta$ -defensin (AvBDs) and pro-inflammatory cytokines in the chick intestine against TLR ligands***

Toll-like receptors (TLRs) recognize the bacterial components (microbe-associated molecular patterns; MAMPs), then induce the expression of innate immune molecules including AMPs and cytokines. Thus, it was examined whether different TLR ligands (bacterial pattern) affect the expression of the innate immune factors (proinflammatory cytokines and AvBDs) in the chick intestine.

#### ***Chapter 4. Effect of antibiotics treatment on the microbial composition and expression of antimicrobial peptide and cytokines in the chick cecum***

The evidence showing that the microbiota complex directly affect the innate immune system in the intestine remains to be confirmed. Thus, it was examined whether antibiotics administration affected the intestinal microbiota in the cecum contents and the expression of innate immune molecules including TLRs, pro- and anti-inflammatory cytokines, and AMPs in the chick intestine.

#### ***Chapter 5. Effect of probiotics treatment on the microbial composition and expression of antimicrobial peptides and pro- and anti-inflammatory cytokines in the chick ileum and cecum***

The live probiotics treatments are expected to improve microbiota complex and metabolome in the intestinal contents and the expressions of immune molecules in intestinal mucosa. The aim of this study was to determine the effect of different commercial probiotics on the innate immune molecules (TLRs, pro- and anti-inflammatory cytokines, and AMPs) in the chick intestine.

#### ***Chapter 6. General discussion***

General discussion on the characterization of developmental profiles of innate immune system, the role of microbiota in the expression of molecules involved in that system, and the possibility that intestinal microbiota regulation may enhance the immune system in the chick intestine constitute Chapter 6.