Enriched environment improves the resistance to transport stress in laying hens via modulating the heat shock protective response and inflammation

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Abstract
Enriched environment can promote the adaptability of animals to cope with the complex environments. To evaluate how enriched environment experience can help laying hens resist to transport stress, hens from conventional battery cages and furnished cages was selected for 4h transportation. The spleen was collected before transportation, after the transportation and 48h for recovery.

Results

1. The results of expression levels of HSPs and HSFs of laying hens

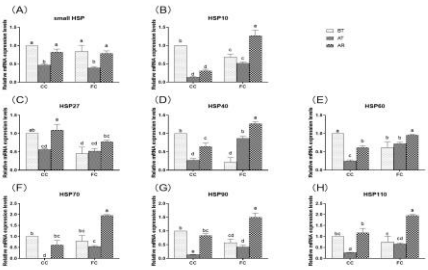

Fig. 1 Changes in Small HSP, HSP10, HSP27, HSP40, HSP60, HSP70, HSP90, HSP110 mRNA expression levels in spleens of laying hens in CC and FC before transportation (BT), after transportation (AT) and after recovering for 48h (AR). Lowercase letters "a, b, c" indicate significant differences ($P < 0.05$), and the same or non-standard means no significant differences ($P > 0.05$)

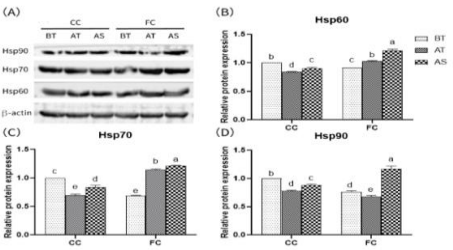

Fig. 2 Changes in HSP60, HSP70, and HSP90 protein expression levels.

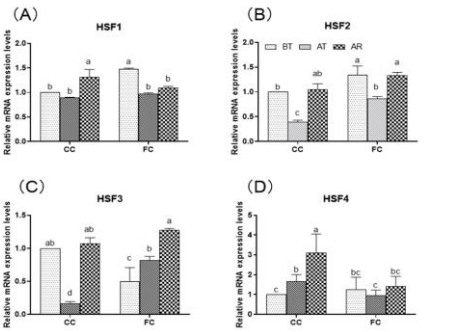

Fig. 3 Changes in HSF1, HSF2, HSF3, and HSF4 mRNA expression levels.

Expression of most of detected HSPs and HSFs indicators were decreased after transportation and then elevated later. The mRNA levels of HSP10, 40, 60, 70, 90 and 110, HSF2 and HSF3 and the protein expression of HSP 60, 70 and 90 were higher in FC group than CC after the transportation and recovery.

2. Expression levels of inflammatory factors in spleen of laying hens

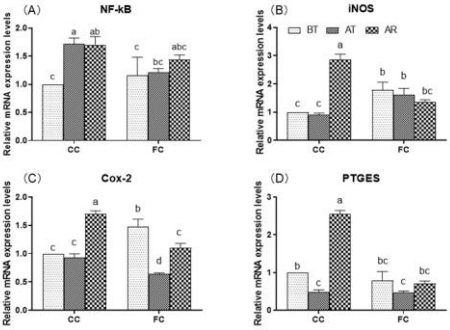

Fig. 4. Hens housed in FC group had the lower mRNA expression of pro-inflammatory factors of nuclear transcription factor (NF-κB), cyclooxygenase-2 (COX-2) and prostaglandin E synthase (PTGEs) before and after the transportation compared to CC group ($P < 0.05$).

3. Cytokines levels in spleen and serum of laying hens

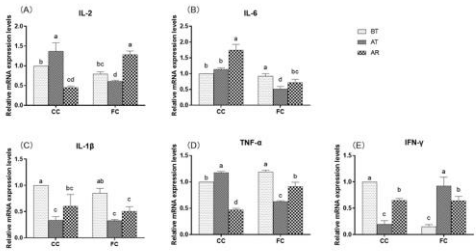

Fig. 5 Changes in cytokines expression levels.

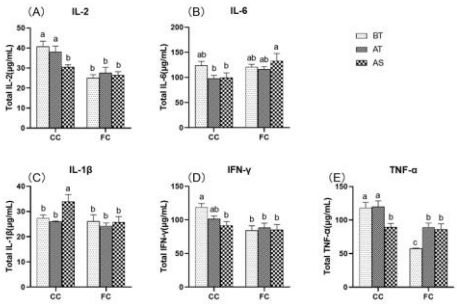

Fig.6 Changes in serum cytokines

The results of Fig.5 and Fig.6 showed that the mRNA expression of inflammatory cytokines of interleukin-2 (IL-2), -6 (IL-6) and tumor necrosis factor (TNF-α) and serum concentration of IL-1β and TNF-α in FC hens were lower than CC after the transportation ($P < 0.05$),

Conclusion
The enriched environment can reduce the stress damage of laying hens and improve the resistance to transport stress by regulating the heat shock protective response and inflammatory cytokines expression.

Acknowledgments
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