Indian Journal of Animal Sciences **91** (1): 28–30, January 2021/Short communication
https://doi.org/10.56093/ijans.v91i1.113269

Thyroid hormones and Corticosterone investigation under heat stress in native chicken

A VARUN[1]✉, A V OMPRAKASH[2], K KUMANAN[1], S VAIRAMUTHU[1] and N KARTHIKEYAN[2]

Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu 600 051 India

Received: 30 October 2018; Accepted: 8 April 2019

Keywords: Aseel, Corticosterone, Naked neck, Thermal conditioning, Thyroid hormones

Chickens were highly susceptible to high environmental temperature due to lack of sweat glands and high metabolic rate which leads to increased mortality and enormous economic losses every year. Hyperthermia induces blood compositional changes, including metabolic and endocrine alterations (Habibian *et al.* 2014). Thyroid hormones were well known to be influenced by stress and act on multiple metabolic processes. Several researchers reported reduced concentrations of T_3 and T_4 in heat stressed chickens. The inverse relationship exists between concentration of thyroid hormones and environmental temperature, corticosterone (Iqbal *et al.* 1990).

In broilers, thermal conditioning at an early age resulted in improved thermotolerance and reduced mortality when re-exposed to heat in later life (De Basilio *et al.* 2001). Early thermal conditioning seems to be one of the most promising methods to improve the adaptability of chickens to heat stress. Hence, the objective of this study was to evaluate the effect of thermal conditioning on different native chicken strains in amelioration of heat stress and normalization of serum T_3 and T_4 and corticosterone levels.

The study was conducted at Poultry Research Station, Tamil Nadu Veterinary and Animal Sciences University, Chennai and all experimental procedures were approved by the Institutional Animal Ethical Committee (IAEC). Twelve weeks duration study was conducted to evaluate the effect of thermal conditioning in four different native chicken strains namely Aseel, Naked Neck (NN), Assel × Nandanam chicken-4 (ARW) and Naked Neck × Nandanam Broiler-3 (NNB3). A total of 960 chickens, i.e. 240 numbers of each variety with straight run chicks were used in the study. Chicks from four varieties (ASL, ARW, NN, NNB3) were divided into control (C) and heat exposed (H) groups. The C chicks were reared in ambient temperature (28±1°C). H group chicks were exposed to 39±1ºC for 2 hrs daily during 0–2 weeks and 5–6 weeks of age, in the thermal chamber using thermostat controlled equipment. At 12th week, control group were divided into two groups, i.e. unexposed control (C) and sudden exposed control (CE). Birds from H group (HE) and CE group were thermal challenged at 39±1°C for 4 hours daily on 12th week.

On 42nd and 84th day, blood was withdrawn from each group, serum separated and processed for T_3, T_4 and CORT by commercially available Radioimmunoassay kit (Immunotech, Czech Republic) as per the manufactures recommendation. The hormone level was expressed in ng/dl. The data collected were subjected to statistical analysis of one way ANOVA and T test as per the procedure of statistical analysis system (SPSS version 20.0 for windows).

Statistical analysis of hormone levels on thermal conditioning and thermal challenge were presented in Table 1. On 42nd day, T_3 and T_4 concentration was significantly ($P<0.01$) decreased in H group when compared with control (C) group in all the chicken strain. Among the strains, NN broiler had significantly low T_3 concentration on 42nd day. However at 84th day, sudden exposure to high temperature for longer duration (CE group), had significantly lower T_3 and T_4 concentration, while the pre-exposed group (HE) had significantly high T_3 and T_4 levels and also comparable with C group. Metabolism in birds during growth and production was regulated by thyroid hormone; therefore it is important in adaptation of birds to heat stress. On 42nd day, the T_3 and T_4 concentration was significantly lower in heat exposed birds. Whereas, at 84th day of age the T_3 and T_4 concentration was significantly lower in CE group indicating the stress condition. However, T_3 and T_4 levels in HE group were significantly higher than CE and significantly lower than C group on 84th day, indicating that the pre-exposed birds were able to acclimatise high temperature upon re-exposure to heat stress.

Heat stress depresses the activity of the thyrotrophic axis in birds which reflected by decreased plasma T_3 and T_4 levels. Thermal conditioning in birds resulted in improved thermo-tolerance. Thyroxin (T_4) is considered to be a prohormone of the more biologically active 3, 5, 32-triiodothyronine (T_3). The T_3 and T_4 play important roles in regulating metabolism and thermogenesis of chicken. The present findings with respect to decreased T_3 levels in NN and NNB3 broiler strains were in agreement with the findings of Vinoth *et al.* (2016) reported that there was a significantly decreased T_3 levels in the heat exposed Punjab

Present address: [1]Madras Veterinary College, Chennai 600 007; [2]Poultry Research Station, TANUVAS, Chennai 600 051.
✉Corresponding author e-mail: varunsivagangai92@gmail.com

Table 1. Effect of thermal conditioning and thermal challenge on Triiodothyronine (T3), Thyroxine (T4) and Corticosterone (ng/dl) in different chicken strains (Mean ± SE)

Strain	*Triiodothyronine (T_3) (ng/dl)*						
	42 day			84 day			
	C	H	t-value	C	HE	CE	F-value
Aseel	2.093^{bA}±0.008	1.963^{aB}± 0.009	5.68**	2.097^{bA}±0.024	1.987^{aB}±0.015	1.743^{aC}±0.012	105.08**
ARW	2.117^{abA}±0.018	1.873^{bB} ±0.018	9.16**	2.127^{abA}±0.019	1.963^{abB}±0.009	1.693^{abC}±0.009	287.36**
NN	2.163^{aA}±0.009	1.793^{cB} ±0.022	6.41**	2.173^{aA}±0.012	1.920^{bcB}±0.006	1.660^{bC}±0.015	480.76**
NNB3	2.157^{aA}±0.024	1.823^{bcB}±0.032	9.93**	2.180^{aA}±0.015	1.950^{cB}±0.006	1.667^{abC}±0.027	196.17**
F value	4.107*	11.581**		4.818*	8.708**	4.775*	
Thyroxine (T_4) (ng/dl)							
Aseel	11.25^{cA}±0.34	8.21^{cB}±0.19	6.22**	10.75^{bA}±0.29	9.23^{cB}±0.32	7.81^{cC}±0.10	340.4**
ARW	11.82^{bcA}±0.14	8.86^{bB}±0.07	6.34**	11.37^{bA}±0.09	9.29^{cB}±0.05	7.33^{dC}±0.21	225.7**
NN	13.42^{aA}±0.35	9.21^{aB}±0.19	9.11**	12.65^{aA}±0.34	11.79^{aB}±0.12	9.13^{bC}±0.13	395.6**
NNB3	13.17^{abA}±0.32	9.51^{aB}±0.04	9.64**	12.52^{aA}±0.14	10.27^{bB}±0.08	9.60^{aC}±0.26	615.9**
F value	11.81**	25.11**		14.6**	148.72**	376.17**	
Corticosterone (ng/dl)							
Aseel	8.13^{cB}±0.05	22.34^{cA}±0.41	40.24**	8.56^{bC}±0.16	17.65^{bB}±0.19	23.86^{cA}±0.26	535.59**
ARW	8.92^{bB}±0.07	23.41^{bcA}±0.43	42.94**	8.91^{abC}±0.08	18.14^{bB}±0.16	24.53^{bA}±0.29	710.55**
NN	9.27^{aB}±0.08	25.13^{aA}±0.26	45.06**	9.21^{aC}±0.13	19.74^{aB}±0.18	25.79^{aA}±0.07	281.63**
NNB3	9.31^{aB}±0.04	24.02^{abA}±0.21	47.71**	9.12^{aC}±0.02	19.55^{aB}±0.41	24.63^{bA}±0.29	352.16**
F value	75.28**	11.76**		6.83*	16.51**	10.76**	

C, Control; H, Thermal Conditioned (39±1°C-2h); CE, Control exposed (84 d; 39±1°C-4 h); HE, Heat Exposed (84 d; 39±1°C-4 h). ARW, Aseel × Nandanam Chicken-4; NNNB-3, Naked Neck ×Nandanam Broiler-3; NN, Naked Neck; AT, Ambient temperature. ^{a,b,c}Means with different superscript within same columns have significant differences. ^{A,B,C}Means with different superscript within same rows have significant differences. NS, Non-significant; *, Significant (P<0.05); **, Highly significant (P<0.01).

broiler-2 birds. Liang *et al.* (2016) observed the plasma T_3 levels was significantly decreased in heat exposed birds. The present findings were in disagreement with Rajkumar *et al.* (2015) who reported that a non-significant difference exists between the heat exposed and unexposed group with respect to T_3 levels. The importance of thyroid hormones in adaptation to heat stress was related to its role in regulation of the metabolic rate in birds during growth and production.

On 42nd day, CORT concentration was significantly (P<0.01) elevated in H group when compared with control (C) group. Among the strains, NNB3 and NN had significantly (P<0.05) elevated CORT levels. However at 84th day CE group, sudden exposed to high temperature for longer duration had significantly (P<0.01) elevated CORT level, while the pre-exposed group (HE) had significantly low CORT level when compared to CE group but significantly high when compared to control (C) group. Among the varieties, NNB3 and NN had elevated CORT level.

Corticosterone level was used as an indicator to access the quantum of stress. The present findings with respect to increased CORT in NN and NNB3 broiler strain were in agreement with the findings of Rimoldi *et al.* (2015) who recorded increased CORT level in the heat exposed birds when compared with the control birds. However, the present findings were in disagreement with the findings of El-Azim (2012) who showed that a non-significant difference exists between the heat exposed and unexposed group with respect to CORT level. This difference in corticosterone value among different strains might be due to differences in the heat exposed period and genetic makeup of the groups used in the study.

Heat stress is one of the factors that activate the hypothalamic-pituitary-adrenal (HPA) axis. The stress activated HPA axis, leads to rapid release of corticotropin-releasing hormone (CRH) and adreno-corticotropic hormone (ACTH) from the cells located in the hypothalamus and pituitary, respectively. ACTH stimulates the synthesis and release of steroids from the adrenal cortex, namely corticosterone (Jahejo *et al.* 2016). The birds exposed to high temperature, which causes the release of corticosterone into the blood circulation, which will aid in the metabolism of the birds. The lower corticosterone level in the thermal conditioned groups suggests that the birds were successfully habituated to the heat stress. It was also found that the blood CORT concentration is negatively correlated with feed intake, which will help to reduce further heat increment by digestion and metabolism.

From the present study it was noticed that that thyroid and corticosterone hormones were influenced by thermal conditioning, which can be used as an indicator to assess the quantum of heat stress. It was also noted that the thermal conditioning leads to gradual acclimation to long term heat exposure which was indicated by drop in corticosterone level.

SUMMARY

The study was conducted to evaluate the effect of thermal conditioning on serum levels of Triiodothyronine (T_3),

thyroxine (T_4) and corticosterone (CORT) in four different chicken strains namely Aseel, Naked Neck, Assel × Nandanam chicken-4 and Naked Neck × Nandanam Broiler-3. Chicks were divided into control (C; ambient temperature 28±1°C) and heat exposed groups (H; 39±1°C for 2 hours; 0–2 and 5–6 weeks of age). At 12th week, control group were divided into two groups, i.e. unexposed control (C) and exposed control (CE). Birds from H group (HE) and CE group were thermally challenged at 39±1°C for 4 hours daily on 12th week. On 42nd and 84th day, blood was withdrawn from each group, serum separated and processed for T_3, T_4 and CORT. The results indicated that the thermal conditioning had significantly decreased T_3, T_4 and increased CORT levels, irrespective of strains. At thermal challenge, a drastic drop in CORT level and improvement in thyroid hormone levels were noticed in the preconditioned birds. From present study, it was concluded that, the birds are able to withstand the heat stress effect which was indicated by drop in CORT level.

REFERENCES

De Basilio V, Vilarin M, Yahav S and Picard M. 2001. Early age thermal conditioning and a dual feeding program for male broilers challenged by heat stress. *Poultry Science* **80**(1): 29–36.

El-Azim A A. 2012. Improve the heat tolerance of broilers through heat treatment during the first two weeks. *Egypt Journal of Poultry Science* **32**: 483–95.

Habibian M, Ghazi S, Moeini M M and Abdolmohammadi A. 2014. Effects of dietary selenium and vitamin E on immune response and biological blood parameters of broilers reared under thermoneutral or heat stress conditions. *International Journal of Biometeorology* **58**(5): 741–52.

Iqbal A, Decuypere E, AbdAzimEl A and Kühn E R. 1990. Pre- and post-hatch high temperature exposure affects the thyroid hormones and corticosterone responses to acute heat stress in growing chicken (*Gallus domestica*). *Journal of Thermal Biology* **15**: 149–53.

Jahejo A R, Rajput N, Rajput N M, Leghari I H, Kaleri R R, Mangi R A, Sheikh M K and Pirzado M Z. 2016. Effects of heat stress on the performance of hubbard broiler chicken. *Cells, Animal and Therapeutics* **2**(1): 1–5.

Liang H M, Lin D Y, Hsuuw Y D, Huang T P, Chang H L, Lin C Y, Wu H H and Hung K H. 2016. Association of heat shock protein 70 gene polymorphisms with acute thermal tolerance, growth, and egg production traits of native chickens in Taiwan. *Archives Animal Breeding* **59**(2): 173–81.

Rajkumar U, Vinoth A, Shanmugam M, Rajaravindra K S and Rama Rao S V. 2015. Effect of embryonic thermal exposure on heat shock proteins (Hsps) gene expression and serum T3 concentration in two broiler populations. *Animal Biotechnology* **26**(4): 260–67.

Rimoldi S, Lasagna E, Sarti F M, Marelli S P, Cozzi M C, Bernardini G and Terova G. 2015. Expression profile of six stress-related genes and productive performances of fast and slow growing broiler strains reared under heat stress conditions. *Meta Gene* **6**: 17–25.

Vinoth A, Thirunalasundari T, Shanmugam M and Rajkumar U. 2016. Effect of early age thermal conditioning on expression of heat shock proteins in liver tissue and biochemical stress indicators in colored broiler chicken. *European Journal of Experimental Biology* **6**(2): 53–63.