

Influence of different tropical stress conditions on biochemical parameters in various broiler strains

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ABSTRACT

The present experiment was conducted to study the effect of different tropical stress conditions on biochemical traits in various broiler strains during 3 to 4 weeks of age. Introgressing some important major genes like Naked neck (Na) and Frizzle (F) into broiler germplasm may substantially improve the heat tolerance. Hence, the experiment was designed to evaluate three indigenously developed broilers viz. CARIBRO-Tropicana (Naked neck and Frizzle gene bearing), CARIBRO-Mritunjai (Naked neck gene bearing) and CARIBRO-Vishal (Normal plumaged) under different THI (i.e. 72, 85 and 91) for 4 hours daily for 7 days. Total 324 broiler chicks (i.e. 36 chicks in each group) of 3 weeks of age were used in this study. The changes in blood biochemical parameters (i.e. Na, K, Glucose and ACTH) were examined in these experiments at 0th, 3rd and 7th into exposure trials. The glucose, ACTH were observed lowest in frizzle and highest in normal plumaged birds under different THI. In experiment Na and K were observed higher in Frizzle and lowest in normal plumaged birds under different THI. The CARIBRO-Vishal showed highest stress as compared to other group. Higher the THI more severe was the effect on the traits. During the 7 day of exposure trial, birds of all the genetic group exhibited the phenomenon of acclimatization as revealed by the averages of various traits at different days into the exposure.

Key word: ACTH, Biochemical traits, Broiler strains, Glucose, Tropical stress.

INTRODUCTION

The utilization of major genes for broiler production under tropical conditions exudes much enthusiasm among the poultry breeders. The important major genes are Naked neck (Na), Dwarf (dw) and Frizzle (F). These genes are located on Autosomes and get inherited in Mendelian fashion. Introgressing some important major genes into the poultry germplasm may substantially improve the heat tolerance ability of broilers without reducing their economic performance. Some major genes result in reduction of feather cover while other exerts their effect by decreasing the metabolic heat output (Merat *et al.*, 1986; Cahaner and Leenstra, 1992). Involvement of endocrine system in stress regulation comprised of hypothalamus-pituitary-adrenal axis (HPA) (Seyle, 1956). It is characterized by adrenal cortical hypertrophy, increased synthesis and release of adrenal glucocorticoids, known as corticosterone in bird. The endocrine mechanism of stress regulation is started with the stimulation of hypothalamus and release of ACTH from anterior pituitary which causes the increase of adrenal cortical steroid secretions. Continuous stimulation to adrenal cortex leads to chronically high level of corticosteroid hormones.

This hormone is responsible for the formation of glucose from the body reserve of carbohydrates, lipids and proteins.

MATERIALS AND METHODS

The CARIBRO-Mritunjai (Necked neck plumaged), CARIBRO-Tropicana (Naked neck and Frizzle plumaged) and CARIBRO-Vishal (normal plumaged) broiler chicks developed at Experimental Broiler Farm, C.A.R.I., Izatnagar, were used in this study.

Fertile eggs were collected at Experimental Broiler Farm for incubation. Total of 36 chicks (three weeks old) of CARIBRO-Mritunjai, CARIBRO-Tropicana and CARIBRO-Vishal each, for each exposure trial were used. The chicks were reared up to 3 weeks of age at Experimental Broiler Farm (EBF) under uniform nutrition and management. The chicks were reared at litter with *ad lib* feeding of starter ration. At three weeks of age the chicks were shifted to Psychometric chamber for exposure under particular THI for a period of 7 days. Three weeks old chicks (36) of each germplasm were used in this study in each exposure trial totaling to 108 chicks of each genetic group.

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in the three exposure trials and 324 chicks of all genetic groups in all exposure trials.

The evaluation of these stocks was carried out at three different “Thermal Humidity Index” (THI) in three separate trials. The birds of each genetic groups were kept in Psychometric chamber at an age of 3 week and the chamber was set to provide specific temperature and humidity for a particular THI. The desired temperature and humidity at each THI were provided for a period of 4 hours daily for experimental duration of 7 days.

- THI 1 (72): Temperature: $23 \pm 1^\circ\text{C}$ and Relative humidity: $40 \pm 5\%$ (Zone of comfort) (Experiment No.1)
- THI 2 (85): Temperature: $35 \pm 1^\circ\text{C}$ and Relative Humidity: $50 \pm 5\%$ (Mild stress) (Experiment No.2)
- THI 3 (91): Temperature: $41 \pm 1^\circ\text{C}$ and Relative Humidity: $45 \pm 5\%$ (High stress) (Experiment No.3)

At 0th, 3rd and 7th day of experimental exposure following parameters were recorded i. Blood glucose level, ii. ACTH level (0th and 7th day of experiment), iii. Na and K level

Sample Size: For estimation of blood biochemical, a sample of 10 birds was used in each genetic group at each time point.

Recording of various parameters: For analysis of blood biochemicals, blood was collected from individual birds on specified day of experiment soon after THI exposure (i.e. 4 hours daily on a particular THI). Blood glucose level in blood serum was measured by Glucose estimation kit M/s Span Diagnostic Limited, Surat, India. ACTH levels in blood serum were measured employing RIA using ACTH IRMA Kit, M/s Anand Brothers, New Delhi. Sodium concentration was estimated from blood serum by using SP Twin Kit, M/s Span Diagnostic Limited, Surat, India. Potassium level was estimated in blood serum by using SP Twin Kit, M/s Span Diagnostic Limited, Surat, India.

RESULTS AND DISCUSSION

Climate change and increase in ambient temperature have attracted the attention of scientists and researchers which led to efforts for analyzing the effects of the climate shift on various livestock and agricultural crop species including their production performance.

TABLE 1: Serum glucose (mg/dl) in broiler chicken of different genetic groups at different days during experimental period under different THI (Mean $\pm$ SE)

Day of experiment	THI	CARIBRO-Tropicana (T1)	CARIBRO-Mritunjai (T2)	CARIBRO-Vishal (T3)	Overall mean
0 th (After Exposure)	THI<72	179.97 ^{aA} $\pm$ 2.16 (10)	188.71 ^{bA} $\pm$ 2.79 (10)	199.04 ^{cA} $\pm$ 1.87 (10)	189.24 $\pm$ 1.33 (30)
	THI85	207.47 ^{aB} $\pm$ 0.38 (10)	228.10 ^{bb} $\pm$ 1.73 (10)	253.13 ^{cB} $\pm$ 2.99 (10)	229.56 $\pm$ 1.17 (30)
	THI91	256.80 ^{aC} $\pm$ 1.32 (10)	273.86 ^{bc} $\pm$ 1.30 (10)	296.23 ^{cC} $\pm$ 0.69 (10)	225.63 $\pm$ 0.66 (30)
	Overall mean	214.74 $\pm$ 0.87 (30)	230.22 $\pm$ 1.18 (30)	249.46 $\pm$ 1.19 (30)	
3 rd	THI<72	178.86 ^{aA} $\pm$ 1.12 (10)	187.76 ^{bA} $\pm$ 1.48 (10)	198.15 ^{cA} $\pm$ 4.76 (10)	188.26 $\pm$ 1.70 (30)
	THI85	204.23 ^{aB} $\pm$ 1.38 (10)	226.92 ^{bb} $\pm$ 2.46 (10)	249.93 ^{cB} $\pm$ 2.57 (10)	227.02 $\pm$ 1.27 (30)
	THI91	254.22 ^{aC} $\pm$ 0.81 (10)	268.51 ^{bc} $\pm$ 1.66 (10)	292.62 ^{cC} $\pm$ 1.65 (10)	271.78 $\pm$ 0.82 (30)
	Overall mean	214.44 $\pm$ 0.65 (30)	227.73 $\pm$ 1.10 (30)	246.90 $\pm$ 1.19 (30)	
7 th	THI<72	177.09 ^{aA} $\pm$ 1.35 (10)	184.77 ^{bA} $\pm$ 0.84 (10)	196.39 ^{cA} $\pm$ 2.33 (10)	186.08 $\pm$ 0.94 (30)
	THI85	194.37 ^{aB} $\pm$ 1.15 (10)	215.82 ^{bb} $\pm$ 0.89 (10)	246.43 ^{cB} $\pm$ 2.27 (10)	218.87 $\pm$ 0.52 (30)
	THI91	252.99 ^{aC} $\pm$ 0.67 (10)	267.18 ^{bc} $\pm$ 2.01 (10)	287.91 ^{cC} $\pm$ 1.97 (10)	269.36 $\pm$ 0.96 (30)
	Overall mean	208.15 $\pm$ 0.63 (30)	222.59 $\pm$ 0.78 (30)	243.58 $\pm$ 1.03 (30)	

Note:

1) Figures in parentheses are the number of observations

2) Figure bearing same superscript (lower case) in a row and (upper case) in a column within day of experiment do not differ significantly ($P \leq 0.05$)

3) The figures bearing different superscript (symbol) differ significantly in a particular THI during different days in a column.

Blood glucose level (mg/dl): The mean blood glucose levels of different genetics groups of different days of experiment under different THI have been present Table 1. The differences among three genetic groups were significant ($P<0.05$) at 0th, 3rd and 7th day of experiment at THI 72, 85 and 91. The lowest blood glucose levels ($P<0.05$) at all the time points under different THIs were exhibited in CARIBRO-Tropicana (177.09 ± 1.35 to 256.80 ± 1.32) as compared to CARIBRO-Vishal (196.39 ± 2.33 to 296.23 ± 0.69) and CARIBRO-Mritunjai (184.77 ± 0.84 to 273.86 ± 1.30). The effect of THI was significant ($P<0.05$) on blood glucose level in different periods in each of the genetic groups. The blood glucose level were significantly ($P<0.05$) higher at THI 91 (252.99 ± 0.67 to 296.23 ± 0.62) than at THI 72 (177.09 ± 1.35 to 253.13 ± 2.99) and 85 (194.37 ± 1.15 to 253.13 ± 2.99) in the three genetic groups. Our means of CARIBRO-Vishal (287.91 mg/dl) at 7th day under THI 91 were comparable to those reported by Borges *et al.*, (2004) at 41°C for 45 minutes (283.4 mg/dl) in 6 weeks old Cobb male broiler. Effect of THI on glucose levels at different days was also found significant in present investigation. Significant effect of higher ambient temperature on glucose levels at different days was also found in present investigation. Significant effect of higher temperature on glucose levels in broilers have also been reported in literature (Zulkifli *et al.*, 1999; Aksit *et al.*, 2006; Olanrewaju *et al.*, 2010; Borges *et al.*, 2004). Higher glucose levels have been reported at high stress condition. Our results were in agreement to the earlier reports.

ACTH level (pg/ml): The ACTH levels of different genetic groups have been present in Table 2 at different days of

experiment under different THI. The differences among three genetic groups were significant ($P<0.05$) at 0th and 7th day of experiment at THI 72, 85 and 91. Lower ACTH levels at both the time points under different THIs were exhibited in CARIBRO-Tropicana (1.73 ± 0.22 to 4.42 ± 0.08 pg/ml) followed by CARIBRO-Mritunjai (1.89 ± 0.12 to 5.54 ± 0.11 pg/ml) and CARIBRO-Vishal (2.20 ± 0.11 to 6.59 ± 0.18 pg/ml). The effect of THI was significant ($P<0.05$) on ACTH levels on different days of experiment in each of the genetic groups. The ACTH levels were significantly ($P<0.05$) higher at THI 91 (4.42 to 6.594) than at THI 72 and 85 in each genetic group. Elevated levels of H/L ratio, glucose levels, corticosteroid and appearance stress related syndrome have been reported in birds given with ACTH injection (Puvadolpirod and Thaxton, 2000; Olanrewaju *et al.*, 2006). The stress responses under prolonged stress situation were more efficient in CARIBRO-Tropicana (Frizzle and Naked neck gene bearing) and CARIBRO-Mritunjai (Naked neck gene bearing) as compared to CARIBRO-Vishal (normally feathered) as has been indicated by our results of biochemical parameters (glucose, sodium, potassium and ACTH). The role of Frizzle and Naked neck gene in tropical adaptability has also been reported in literature (Bordas *et al.*, 1980; Cahaner *et al.*, 1993).

Sodium level (mEq/L): The sodium levels have been present in Table 3 for different genetic groups at different days of experiment under different THIs. The differences among three genetic groups were significant ($P<0.05$) at 0th, 3rd and 7th day of experiment at THI 72, 85 and 91. The higher levels of sodium at all the time points under different THIs

TABLE 2: ACTH level (pg/ml) in broiler chicken of different genetic groups at different days during experimental period under different THI (Mean $\pm$ SE)

Day of experiment	THI	CARIBRO-Tropicana (T1)	CARIBRO-Mritunjai (T2)	CARIBRO-Vishal (T3)	Overall mean
0 th (After Exposure)	THI<72	1.811 ^{aA} $\pm$ 0.186 (7)	2.143 ^{abA} $\pm$ 0.160 (7)	2.524 ^{bA} $\pm$ 0.135 (7)	2.160 $\pm$ 0.093 (21)
	THI85	3.134 ^{aB} $\pm$ 0.142 (7)	3.525 ^{aB} $\pm$ 0.142 (7)	4.135 ^{bB} $\pm$ 0.219 (7)	3.599 $\pm$ 0.096 (21)
	THI91	4.420 ^{aC} $\pm$ 0.096 (7)	5.544 ^{bC} $\pm$ 0.114 (7)	6.594 ^{cC} $\pm$ 0.117 (7)	5.520 $\pm$ 0.063 (21)
	Overall mean	3.120 $\pm$ 0.084 (21)	3.738 $\pm$ 0.077 (21)	4.418 $\pm$ 0.094 (21)	
7 th	THI<72	1.732 ^{aA} $\pm$ 0.219 (7)	1.892 ^{aA} $\pm$ 0.116 (7)	2.202 ^{aA} $\pm$ 0.109 (7)	1.943 $\pm$ 0.090 (21)
	THI85	3.079 ^{aB} $\pm$ 0.074 (7)	3.157 ^{aB} $\pm$ 0.093 (7)	3.688 ^{bB} $\pm$ 0.062 (7)	3.308 $\pm$ 0.045 (21)
	THI91	4.307 ^{aC} $\pm$ 0.080 (7)	5.035 ^{bC} $\pm$ 0.261 (7)	6.437 ^{cC} $\pm$ 0.104 (7)	5.26 $\pm$ 0.097 (21)
	Overall mean	3.04 $\pm$ 0.081 (21)	3.362 $\pm$ 0.100 (21)	4.110 $\pm$ 0.054 (21)	

Note: 1) Figures in parentheses are the number of observations

2) Figure bearing same superscript (lower case) in a row and (upper case) in a column within day of experiment do not differ significantly ($P\leq0.05$)

TABLE 3: Sodium level (mEq/L) in broiler chicken of different genetic groups at different days during experimental period under different THI (Mean±SE)

Day of experiment	THI	CARIBRO-Tropicana (T1)	CARIBRO-Mritunjai (T2)	CARIBRO-Vishal (T3)	Overall mean
0 th (After Exposure)	THI<72	145.97 ^{aA} ±0.20 (10)	145.62 ^{aA} ±0.19 (10)	144.72 ^{bA} ±0.22 (10)	145.43±0.12 (30)
	THI85	143.31 ^{aB} ±0.44 (10)	142.11 ^{abB} ±0.40 (10)	141.13 ^{bB} ±0.46 (10)	142.19±0.25 (30)
	THI91	137.27 ^{aC} ±0.06 (10)	136.42 ^{bC} ±0.11 (10)	135.53 ^{cC} ±0.10 (10)	136.40±0.06 (30)
	Overall mean	142.19±0.16 (30)	141.38±0.15 (30)	140.46±0.17 (30)	
3 rd	THI<72	146.06 ^{aA} ±0.19 (10)	145.70 ^{aA} ±0.19 (10)	144.91 ^{bA} ±0.17 (10)	145.56±0.10 (30)
	THI85	143.37 ^{aB} ±0.30 (10)	142.54 ^{abB} ±0.38 (10)	141.76 ^{bB} ±0.32 (10)	142.56±0.19 (30)
	THI91	137.54 ^{aC} ±0.11 (10)	136.44 ^{bC} ±0.10 (10)	135.57 ^{cC} ±0.10 (10)	136.52±0.06 (30)
	Overall mean	142.32±0.12 (30)	141.56±0.145 (30)	140.75±0.12 (30)	
7 th	THI<72	146.18 ^{aA} ±0.24 (10)	145.87 ^{aA} ±0.24 (10)	144.93 ^{bA} ±0.15 (10)	145.66±0.12 (30)
	THI85	143.67 ^{aB} ±0.37 (10)	142.94 ^{abB} ±0.35 (10)	142.07 ^{bB} ±0.44 (10)	142.89±0.22 (30)
	THI91	137.58 ^{aC} ±0.09 (10)	136.51 ^{bC} ±0.11 (10)	135.69 ^{cC} ±0.05 (10)	136.59±0.50 (30)
	Overall mean	142.48±0.15 (30)	141.77±0.14 (30)	140.89±0.15 (30)	

Note: 1) Figures in parentheses are the number of observations

2) Figure bearing same superscript (lower case) in a row and (upper case) in a column within day of experiment do not differ significantly (P≤0.05)

3) The figures bearing different superscript (symbol) differ significantly in a particular THI during different days in a column.

were exhibited in CARIBRO-Tropicana (137.27±0.06 to 146.18±0.24) as compared to CARIBRO-Vishal (135.57±0.10 to 144.93±0.15) and CARIBRO-Mritunjai (136.42±0.11 to 145.87±0.24). The effect of THI was significant (P<0.05) on sodium level in different period in each of the genetic groups. The sodium level were significantly (P<0.05) lower at THI 91 than at THI 72 and 85 in each genetic groups. Highest sodium levels in each genetic group at each time point were observed at THI 72. Significant differences among days of experiment were observed in CARIBRO-Tropicana at THI 91. Significantly higher sodium level was observed at 7th day (137.58±0.09) as compared to 0th day (137.27±0.06) under THI 91. Our means of CARIBRO-Vishal (135.69 mEq/L at 7th day under THI 91) were comparable to those reported by Borges *et al.*, (2004) at 41°C for 45 min (144.7) in 6 weeks old Cobb male broilers. In present investigation, sodium levels were found to be significantly different among genetic groups under different THIs, with least values observed in CARIBRO-Vishal and highest in CARIBRO-Tropicana. In present investigation, we also found significant effect of different THIs in blood sodium levels at different days.

Differences in sodium levels in broilers due to significant effect of higher temperature have been reported in literature (Belay and Teeter., 1993; Borges *et al.*, 2004; Olanrewaju *et al.*, 2010; Hassan and Reddy, 2012).

Potassium level (mEq/L): The potassium level of different genetic groups at different days of experiment under different THIs have been presented in Table 4. The higher potassium level at all the time points under different THIs were exhibited in CARIBRO-Tropicana (3.87±0.18 to 5.78±0.16) as compared to CARIBRO-Vishal (3.37±0.22 to 5.54±0.26) and CARIBRO-Mritunjai (3.56±0.11 to 5.65±0.27). However, the difference among three genetic groups were non-significant (P<0.05) at 0th, 3rd and 7th day of experiment at THI 72, 85 and 91. The effect of THI was significant (P<0.05) on potassium level in different day of experiment in each of the genetic groups. The potassium levels were significantly (P<0.05) lower at THI 91 (3.37±0.22 to 3.94±0.10) than at THI 72 (5.31±0.20 to 5.78±0.16) and THI 85 (4.00±0.39 to 4.66±0.17) in each genetic groups. Significant effect of higher ambient temperatures on potassium levels have also been reported in literature (Borges *et al.*, 2004; Olanrewaju *et al.*, 2010; Hassan and Reddy, 2012). The potassium levels in

TABLE 4: Potassium level (mEq/L) in broiler chicken of different genetic groups at different days during experimental period under different THI (Mean±SE)

Day of experiment	THI	CARIBRO-Tropicana (T1)	CARIBRO-Mritunjai (T2)	CARIBRO-Vishal (T3)	Overall mean
0 th (After Exposure)	THI<72	5.62 ^{aA} ±0.20 (10)	5.50 ^{aA} ±0.23 (10)	5.31 ^{aA} ±0.20 (10)	5.47±0.12 (30)
	THI85	4.52 ^{aB} ±0.21 (10)	4.43 ^{aB} ±0.54 (10)	4.00 ^{aB} ±0.39 (10)	4.32±0.23 (30)
	THI91	3.87 ^{aC} ±0.18 (10)	3.56 ^{aC} ±0.11 (10)	3.37 ^{aC} ±0.22 (10)	3.60±0.10 (30)
	Overall mean	4.669±0.11 (30)	4.496±0.20 (30)	4.22±0.16 (30)	
3 rd	THI<72	5.68 ^{aA} ±0.13 (10)	5.57 ^{aA} ±0.24 (10)	5.41 ^{aA} ±0.24 (10)	5.55±0.12 (30)
	THI85	4.60 ^{aB} ±0.06 (10)	4.47 ^{aB} ±0.09 (10)	4.01 ^{aB} ±0.12 (10)	4.36±0.05 (30)
	THI91	3.91 ^{aC} ±0.17 (10)	3.61 ^{aC} ±0.23 (10)	3.42 ^{aC} ±0.14 (10)	3.64±1.11 (30)
	Overall mean	4.73±0.07 (30)	4.55±0.11 (30)	4.27±0.10 (30)	
7 th	THI<72	5.78 ^{aA} ±0.16 (10)	5.65 ^{aA} ±0.27 (10)	5.54 ^{aA} ±0.26 (10)	5.66±0.14 (30)
	THI85	4.66 ^{aB} ±0.17 (10)	4.49 ^{aB} ±0.15 (10)	4.09 ^{aB} ±0.41 (10)	4.41±0.16 (30)
	THI91	3.94 ^{aC} ±0.10 (10)	3.67 ^{bC} ±0.08 (10)	3.45 ^{bC} ±0.09 (10)	3.68±0.052 (30)
	Overall mean	4.80±0.08 (30)	4.60±0.11 (30)	4.36±0.16 (30)	

Figure bearing same superscript (lower case) in a row and (upper case) in a column within day of experiment do not differ significantly ($P \leq 0.05$)

different broiler stocks/genotypes under different thermal stress conditions have been reported by various workers (Borges *et al.*, 2004; Olanrewaju *et al.*, 2010; Belay and Teeter., 1993; Hassan and Reddy, 2012). Slightly lower than our means of CARIBRO-Vishal (3.45) at 7th day of experiment under THI 91 have been reported by Borges *et al.*, 2004 at 41°C for 45 minutes (5.51) in 6 weeks old Cobb male broiler. Reduction in plasma levels of potassium (K^+) might be due to hemodilution, following increased water consumption during heat stress (Borges *et al.*, 2004).

CONCLUSIONS

The differences due to THI and genetic groups were found significant for most of the biochemical traits studied.

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The glucose and ACTH levels increased whereas Na & K declined at higher THIs. During the 7 day exposure trial, birds of all the three genetic groups exhibited the phenomenon of acclimatization as revealed by the averages of various traits at different days into the exposure. Among the three genetic groups, CARIBRO-Tropicana exhibited highest tolerated the heat stress in a better way; therefore CARIBRO-Tropicana was adjudged to be the best genetic group for production under tropical climate.

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