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Comparative Ability to Tolerate Heat Between Thai Indigenous Chickens, Thai Indigenous Chickens Crossbred and Broilers by Using Plasma Glucose

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Abstract: The effects of high environmental temperature on plasma glucose were determined for a comparison of the ability to tolerate heat between Thai indigenous chickens, Thai indigenous chickens crossbred and broilers. One kilogram of males and females from the three breeds were maintained at an environmental temperature at 26±2 and 38±2°C. Plasma glucose was investigated on day 1, 7, 14, 21 and 28 of experimental period. The results revealed the following information: the plasma glucose of chickens at the high environmental temperature was significantly higher than that of chickens at thermoneutral ($p<0.05$). The plasma glucose of the Thai indigenous chickens, Thai indigenous chicken crossbreds and broilers maintained in each temperature condition was not significantly different ($p>0.05$). This experiment showed that plasma glucose is not suitable to use to compare the ability to tolerate heat because both the breed and sex of the chicken influence plasma glucose.

Key words: Heat stress, chronic, glucose, Thai indigenous chickens, Thai indigenous chickens crossbred, broilers

INTRODUCTION

Generally, the body temperature of domestic chickens is maintained within a relatively narrow range that is usually reflected by the upper and lower limits of a circadian rhythm in deep body temperature. In well - fed chickens that are neither dissipating heat to the environment nor gaining heat from the environment, the upper limit of the circadian rhythm is usually about 41.5°C and the lower limit is about 40.5°C (Daghir, 1995). After birds are exposed to a high ambient temperature, their body temperature rises to more than the normal body temperature. High heat causes a heavy workload for the physiological system (Aengwanich *et al*., 2003). The environmental temperature was over 32°C, it induced broilers to heat stress (Cooper and Washburn, 1998). When chickens were under heat stress, plasma glucose rose (Yuming *et al*., 1998; Ewing *et al*., 1999; Zulkifli *et al*., 2000; Borges *et al*., 2003, 2004).

Thai indigenous chickens, the wild birds that have been domesticated in rural villages in Thailand over a long time period of time, have become familiar with high environmental temperatures. However, these indigenous chickens had a lower productive performance than broilers, so breeder improved their production by crossbreeding them with chickens imported from overseas. Thai indigenous chickens crossbred was a crossbreed between ½ Thai indigenous chickens (cock), ¼ Rhode Island Red and ¼ Plymouth Rock (hen). Thai indigenous chickens crossbred had a higher productive performance than Thai indigenous chickens. Whereas, knowledge about heat tolerance between Thai indigenous chickens, Thai indigenous chickens crossbred and broilers is limited. Therefore, the purpose of this experiment was to compare heat tolerance between Thai indigenous chickens, Thai indigenous chickens crossbred and broiler by using plasma glucose. Results from this preliminary study would provide fundamental knowledge for improving poultry production by identifying a heat tolerant genetic resource for poultry production in tropical regions.

MATERIALS AND METHODS

Twenty four Thai indigenous chickens (12 males; 12 females), twenty four Thai indigenous chickens crossbred (12 males; 12 females) and twenty four broilers (12 males; 12 females), one kilograms of weight and infectious disease-free were obtained from a commercial farm near Mahasarakham University and transferred to the laboratory of the Faculty of Technology, at Mahasarakham University. The experiment was performed during April-July, 2005. Experiments began after a 7 day adaptation period. The chicks were fed a standard ration *ad libitum* with a continuous supply of light and water. The experimental design was a split-split-plot design in CRD. The main plot was at two temperatures settings i.e., 26±2°C (continuous temperature) and 38±2°C (cyclic temperature; 26±2-38±2-26±2°C). The chickens were maintained at 38±2°C for 8 h/day. The sub plot was 2×3 factorial i.e., sex (male and female) and included the 3 breeds of chicken (Thai indigenous chickens, Thai indigenous chickens crossbred and broiler). Six Thai indigenous chickens, six Thai indigenous chickens crossbred and six broilers were maintained at each environmental temperature setting. On day 1, 7, 14, 21 and 28 of experimental period, blood samples (via wing vein: 1.0 mL) were collected and transferred to tubes containing EDTA as an anticoagulant (Ritchie *et al*., 1994). The samples with anticoagulant were centrifuged at 2500 x g for 5 min. The plasma was separated and transferred into 1 mL cryogenic vials and stored at -20°C. Plasma glucose was analyzed by using a KODAK EKTACHEM analyzer (Kodak Ektachem®; Eastman Kodak Company, Rochester, New York).

All data were analyzed by using the ANOVA procedure of Statistical Analysis System (1990). Means were separated by Duncan's multiple range tests. The level of significance was determined at $p<0.05$.

RESULTS AND DISCUSSION

Thai indigenous chickens, Thai indigenous chicken crossbreds and broilers were maintained at an environmental temperature at 26±2 and 38±2°C and blood glucose was determined on day 1, 7, 14, 21 and 28 of experimental period. Results revealed the following information: On day 1, plasma glucose of male Thai indigenous chickens and Thai indigenous chicken crossbreds at 38±2°C was significantly higher than that of male and female chicken kept at 26±2°C ($p<0.05$). On day 7, the plasma glucose of male and female Thai indigenous chickens and male Thai indigenous chicken crossbreds kept at 38±2°C was significantly higher than that of male and female Thai indigenous chickens, Thai indigenous chicken crossbreds and female broiler kept at 26±2°C ($p<0.05$). On day 14, the plasma glucose of chickens mainly maintained in both conditions was not significantly different ($p>0.05$), whereas, at 38±2°C, the plasma glucose of the male Thai indigenous chickens was significantly higher than that of the female broilers. On day 21, the plasma glucose of chickens in both conditions was not significantly different ($p>0.05$). Moreover, on day 28 of experimental period, the plasma glucose of the male Thai indigenous chickens and male broilers kept at 38±2°C was significantly higher than that of the female broilers kept at 26±2°C ($p<0.05$) (Table 1). Finally, the plasma glucose of chickens kept at 38±2°C was significantly higher than that of chickens maintained at 26±2°C on day 1, 7, 14, 21 and 28 ($p<0.05$) of experimental period (Fig. 1).

After maintaining chickens at 26±2 and 38±2°C, the plasma glucose of the chickens at 38±2°C was significantly higher than that of the chickens at 26±2°C. This was in accord with the report of Yuming *et al*. (1998), Zulkifli *et al*. (2000), Ewing *et al*. (1999) and Borges *et al*. (2003, 2004). The plasma glucose that increased during heat stress involved 2 pathways. The first pathway is the hypothalamic-adrenal medullary stress-response system (SA) and involves the hypothalamus, neurohypophysis, the sympathetic neural pathways to the adrenal medulla and the release of

Table 1: Blood glucose of male and female Thai indigenous chicken (TIC), Thai indigenous chicken crossbred (TICC) and broilers (BC) were maintained at 26±2 and 38±2°C, on day 1, 7, 14, 21 and 28 of experimental period

		Environmental temperature at 26±2°C						
		TIC		TICC		BC		
Parameters	Days	Male	Female	Male	Female	Male	Female	
Glucose	1	218.00^{bc}	208.83^{c}	214.67^{bc}	210.50^{bc}	206.50^{c}	215.17^{bc}	
($g\ dL^{-1}$)	7	203.17^{cd}	205.33^{cd}	205.67^{cd}	204.67^{cd}	212.83^{bcd}	199.17^{d}	
	14	222.33^{ab}	218.17^{ab}	215.83^{abc}	196.83^{c}	230.00^{ab}	210.83^{abc}	
	21	208.00	228.83	207.67	216.67	223.00	187.50	
	28	223.33^{ab}	218.50^{ab}	227.00^{ab}	217.17^{ab}	224.00^{ab}	211.17^{ba,}	
		Environmental temperature at 38±2°C						
		TIC		TICC		BC		
Parameters	Days	Male	Female	Male	Female	Male	Female	SEM
Glucose	1	250.17^{a}	230.00^{abc}	258.33^{a}	230.50^{abc}	240.00^{ab}	229.00^{abc}	2.63
($g\ dL^{-1}$)	7	236.67^{ab}	233.33^{ab}	241.50^{a}	225.0^{abcd}	225.50^{abc}	223.00^{abcd}	2.23
	14	232.33^{a}	213.17^{abc}	226.83^{ab}	219.08^{ab}	226.50^{ab}	210.67^{bc}	1.83
	21	225.17	222.50	227.67	222.17	240.67	218.00	3.08
	28	252.33^{a}	230.83^{ab}	234.33^{ab}	229.17^{ab}	252.83^{a}	225.00^{ab}	2.65

$^{a, b, c \text{ and } d}$ within row, mean with no common superscript differ significantly ($p<0.05$), SEM = Standard error of the mean

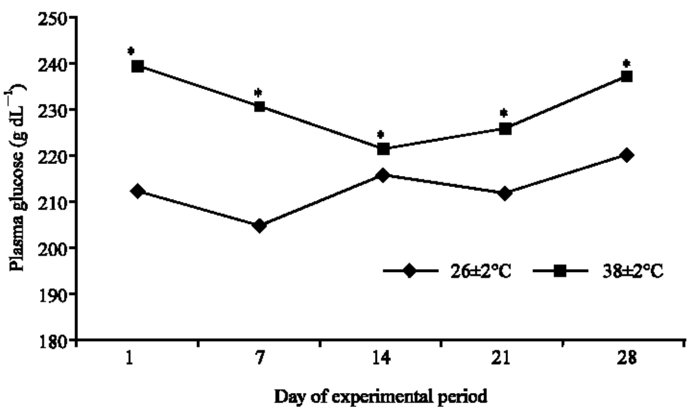

Fig. 1: Plasma glucose pattern of chickens maintained at 26±2 and 38±2°C on days 1, 7, 14, 21 and 28 of experimental period; *significantly different at $p<0.05$

epinephrine by the component of the adrenal medulla (Ewing *et al*., 1999). Epinephrine is involved with the degradation of glycogen in muscle (Kuchel and Ralston, 1988). The second pathway is the hypothalamic-pituitary -adrenocortical stress-response system (HPA). The response represents a sustained longer-term to stressors as compared with the SA system discussed earlier. Effects are heavily oriented toward metabolic changes to strengthen the animal's ability to cope with stressors (Ewing *et al*., 1999). The response in this system is geared to stimulating metabolic activity to provide the energy resources to meet the emergency over an extended period (Balm, 1999; Ewing *et al*., 1999; Downing and Bryden, 2002). The hypothalamus, following the initial stimulus, responds by releasing CRH. This peptide stimulates the anterior hypophysis (anterior pituitary gland) to release adrenocorticotropic hormone (ACTH) (Fox, 1999; Rhoades and Pflanzer, 1989). This hormone activates the adrenal cortex to produce several hormones essential in the stress response (Ewing *et al*., 1999). The major adrenal cortical hormone is glucocorticoid. Corticosterones are glucocorticoids that involved in glucose homeostasis and carbohydrate metabolism (Downing and Bryden, 2002). A prominent action of corticosterone is to promote glucogenesis from non-carbohydrate sources such as amino acids and fatty acids (de La Cruz *et al*., 1981). Therefore, when broilers were under stress, plasma glucose increased (Puvadolpirod and Thaxton, 2000).

On day 1, 7, 21 and 28 of the experimental period, the plasma glucose of chickens at 38±2°C was not significantly different. Whereas on day 14, the plasma glucose of the female Thai indigenous chicken crossbreds at 38±2°C was significantly higher than that of female Thai indigenous chicken crossbreds at 26±2°C, while the plasma glucose of other chickens in both conditions was not significantly different. This occurrence indicated that on day 14 of experimental period female Thai indigenous chicken crossbreds could not adapt to high heat. The plasma glucose of chickens at 38±2°C on each day was not significantly different, while on day 14, the plasma glucose of the female Thai indigenous chicken crossbreds at 26±2°C was significantly lower than that of the male and female Thai indigenous chickens, male Thai indigenous chicken crossbreds and male broilers. This phenomenon shows that the breeds or the sex of chickens influence plasma glucose.

CONCLUSION

Plasma glucose has been widely used as a indicator of stress in various species. When chickens were maintained at a high environmental temperature, their plasma glucose was higher than that of chickens at thermoneutral. The plasma glucose of Thai indigenous chickens, Thai indigenous chicken crossbreds and broiler were maintained in each condition were not different. Finally, the breed and the sex of chickens have influence on plasma glucose.

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