Middle-East Journal of Scientific Research 4 (2): 122-126, 2009
ISSN 1990-9233

Effects of Seasonal Change in the Thermal Environment on Physiological Responses of Unsexed Broilers to Dietary Supplementation of Antithyroid Drug Carbimazole

[1]*Abdalla Mohamed Abdelatif and* [1]*Nawal Mohamed Elkhair*

[1]Department of Physiology, Faculty of Veterinary Medicine,
University of Khartoum, P.O. Box 32. Khartoum North, Sudan

Abstract: The objective of this study was to evaluate the physiological responses of the unsexed broilers to dietary supplementation of carbimazole (0.1 g/bird/day) during tropical summer and winter conditions. There were marked changes in most of the parameters investigated. The rectal temperature (T_r) was higher ($P<0.05$) in summer compared to the winter values in both groups, supplementation of carbimazole caused a decrease ($P<0.01$) in (T_r). The mean values of food intake and body weight (BW) were lower ($P<0.05$) in summer in both groups. Supplementation of carbimazole caused decreases in the mean food intake in both seasons ($P<0.05$) and a decrease in the mean B.W. only in winter ($P<0.05$). The plasma glucose concentration was lower ($P<0.05$) in summer and supplementation of carbimazole caused a decrease ($P<0.05$) in the plasma glucose level only in winter. The serum cholesterol concentration was lower ($P<0.05$) in summer and in both seasons supplementation of carbimazole caused an increase ($P<0.05$) in serum cholesterol concentration.

Key words: Broiler · Season Carbimazole · Thermoregulation · Blood constituents

INTRODUCTION

Under tropical conditions, birds are exposed to marked seasonal changes in the thermal environment. The heat load imposes severe stress and results in reduced physiological and productive performance of birds. High ambient temperature associated with hyperthermia, induces marked changes in blood constituents in chickens [1], increase in plasma glucose level [2] and depletion of hepatic and muscle glycogen [3]. Cold exposure decreased plasma glucose level [4].

The thermal environment imposes marked influences on the endocrine function of avian species, particularly the thyroid gland [5]. The thyroid hormones maintain profound effect on the basal level of metabolism and their calorigenic role during cold exposure of birds has been established [6]. Alternatively, exposure to warm environment was shown to be associated with marked decline in the rate of secretion of thyroid hormones [7]. Seasonal fluctuations in the rate of secretion of thyroid hormones have been reported in avian species [8]. However, little information is available regarding the chemical control of thyroid function in relation to circannual changes in the thermal environment under natural tropical conditions. The experimental work reported in our previous study indicated that hypothyroidism can be induced by the antithyroid drug carbimazole in chicks [9]. The investigations reported in this study were designed to examine the effects of season on physiological responses of broilers as influenced by dietary supplementation with the antithyroid drug carbimazole.

MATERIALS AND METHODS

Experimental Birds and Management: Thirty day-old chicks were obtained from a commercial supplier and kept in an animal house (5x3x2.5 m) with concrete floor and sufficient ventilation. The light was provided for 24 hr (natural and/or artificial light). Appropriate cages were designed for individual accommodation of the birds with dry wood shavings as litter. Then the chicks were randomly assigned to two groups of 15 each (A and B). After an adaptation period of 2 weeks, the chicks were assigned to two groups. The control group was fed the standard commercial diet while the treated group was fed the standard commercial diet supplemented by 0.1 g/bird/day of carbimazole (Remedica Ltd.-Limassol-Cyprus).

Corresponding Author: Dr. Abdalla Mohamed Abdelatif, Faculty of Veterinary Medicine,
University of Khartoum, 13314 Shambat, Sudan

Data Collection: During the experimental period which lasted for 21 days (5 weeks of age), the food intake was measured daily at 8:00 a.m while rectal temperature (T_r) and body weight (B.W.) were recorded at intervals of 3 days at 8:00 a.m.

Blood Collection and Analysis: Blood samples were collected from the wing vein weekly at 8:00 a.m. The area of collection was scrubbed by a disinfectant (70% alcohol) before the wing vein (*vena cuanea ulnaris*) was punctured. 2 ml blood samples were collected from the vein using 1 ml plastic disposable syringes. Immediately 0.5 ml of the blood was transferred to capped test tubes containing disodium ethylene diamine tetra-acetate (Na_2 EDT) (0.2 mg/ml of blood) as anticoagulant. Then 0.5 ml of blood was transferred to another test tube containing sodium fluoride as anticoagulant that inhibits the enzymatic reaction [10] and was centrifuged at 3000 r.p.m for 15 min. The plasma separated was used for glucose determination. The rest of the blood sample was allowed to stay for 2 h at room temperature and the serum was separated using a bench centrifuge (Gallenkamp Junior centrifuge) operated at 3000 r.p.m for 15 min. Haemolysis-free serum samples were obtained and stored frozen for the determination of serum cholesterol concentrations using a commercial kits (Randox Laboratory. Ltd. London).

The same experimental protocol was executed during typical summer and winter conditions for 21 days. The data for climatic conditions prevailing during the experimental period were obtained using an aspiration psychrometer (Wilh Lambercht-GmbH-Gottingen-Germany). The mean ambient temperature, T_a during summer was 35.6±1.5°C, mean relative humidity, was RH 20.0±7.5%. During winter T_a was 25.6±1.5°C, RH was 29.0±8.5%.

Statistical Analysis: Statistical analysis was performed according to the procedure of SAS programme [11]. Analysis of variance (ANOVA) test was carried out to examine the effects of the treatment. Mean separation was performed using Duncan Multiple Range Test.

RESULTS

The general pattern of the response presented in Table 1 shows that there was no significant difference between the groups in response to the changes in the thermal environment for rectal temperatures body weight (B.W), food intake and plasma glucose concentration. However, the mean values of serum cholesterol concentration showed a significant ($P<0.05$) difference between the groups. A lower mean value of serum cholesterol was observed in control summer compared to treated summer and winter.

Rectal Temperature (Tr): The thermoregulatory pattern (Fig.1) illustrates fluctuations in rectal temperature (T_r), irrespective of the season. During summer, the (T_r) values of the control group were higher ($P<0.05$) on days 9 and 15 as compared to the initial value. For the treated group, on days 15, 18 and day 21, (T_r) was lower ($P<0.05$) as compared to the control group. During winter, there was a sharp decrease ($P<0.05$) in (T_r) value of the treated group as compared to the control value.

Food Intake: The mean food intake (Fig. 2) showed an almost linear increase with time irrespective of the season. During summer, the mean food intake of the treated group was higher ($P<0.05$) on day 12 and it declined ($P<0.01$) on days 15 and 21 compared to the control value. During winter, the mean food intake of the treated was lower ($P<0.05$) on days 12,15,18 and 21 compared to the control value.

Body Weight: During the experimental period, for both groups, there was an almost linear increase in (BW) with time irrespective of the season (Fig. 3). However, the initial (BW)values of both the control and the treated groups were lower during summer compared to the values obtained during winter.

Plasma Glucose: For both groups, there was a marked decrease in plasma glucose concentration during the experimental period, irrespective of the season (Fig. 5).

Table 1: Statistical data for the whole period after dietary supplementation of carbimazole in unsexed Lohmann chicks for 21days (mean±SD)

	Control (n=15)		Treated (n=15)	
Parameter	Summer	Winter	Summer	Winter
T_r (°C)	41.4^a±0.3	41.3^a±0.3	41.3^a±0.1	41.2^a±0.07
B.W (g)	504.2^a±252.5	652.2^a±254.6	493.1^a±239.8	579.6^a±264
Food intake (g)	52.6^a±22.8	75.1^a±15.6	50.3^a±19	68.9^a±11
Glucose (mg/dL)	174.6^a±56.6	191.7^a±59.2	179^a±24.8	170.3^a±28
Cholesterol (mmol/L)	2.66^a±0.3	4.8^b±0.7	3.1^a±0.8	5.1^b±0.6

^{a,b} Means within the same row bearing different superscripts are significantly different at $p<0.05$

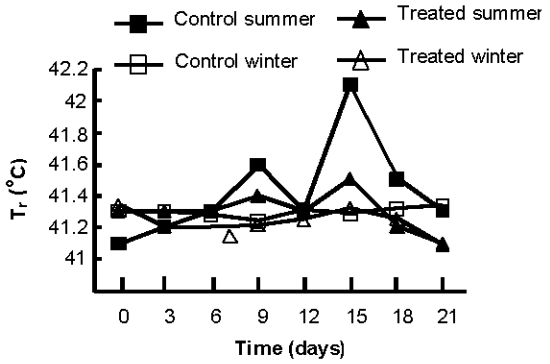

Fig. 1: Effect of dietary supplementation of carbimazole on the mean rectal temperature (Tr) in chicks during summer and winter conditions

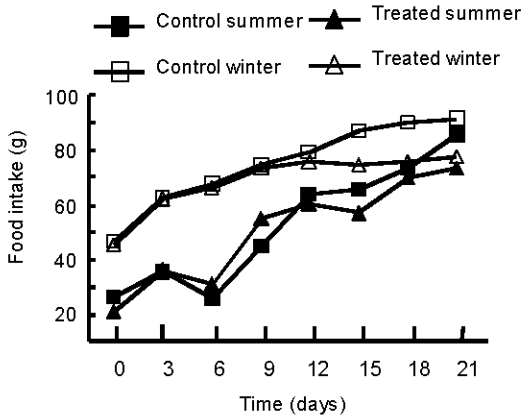

Fig. 2: Effect of dietary supplementation of carbimazole on the mean food intake (g) in chicks during summer and winter conditions

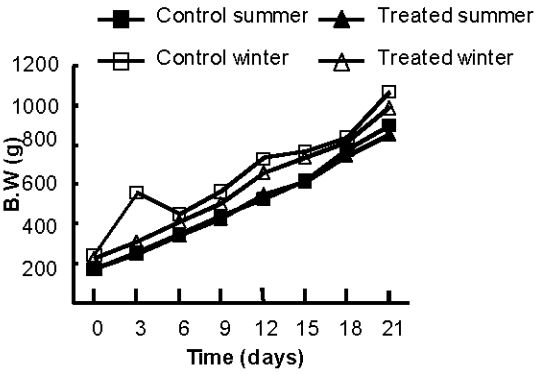

Fig. 3: Effect of dietary supplementation of carbimazole on the mean body weight (B.W) in chicks during summer and winter conditions

During summer, the plasma glucose concentration of the control group decreased ($P<0.05$) on day 21. However, the decrease was not significant in the treated group. During winter, the glucose concentration of the treated group

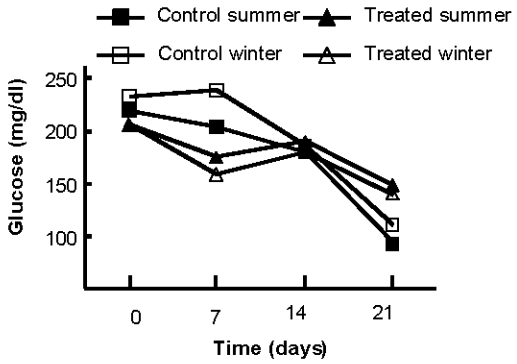

Fig. 4: Effect of dietary supplementation of carbimazole on the mean glucose concentration (mg/dl) in chicks during summer and winter conditions

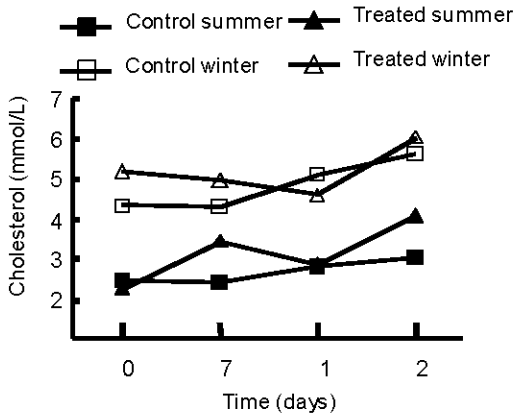

Fig. 5: Effect of dietary supplementation of carbimazole on the mean cholesterol concentration (mmol/l) in chicks during summer and winter conditions

was lower ($P<0.05$) on days 7, 14 and 21 compared to the control value.

Serum Cholesterol: During summer, there was a progressive increase in serum cholesterol concentration of the control group during the experimental period except on day 14 (Fig. 5). For the treated group, there was a sharp increase ($P<0.05$) on day 21. During winter, the serum cholesterol concentration for both groups was higher compared to the summer values measured during the experimental period. The serum cholesterol concentration of the control group increased sharply ($P<0.05$) on day 21. For the treated group, on day 14, serum cholesterol concentration was increased sharply ($P<0.01$) on day 21.

DISCUSSION

The climatic data indicate that the experimental birds have been exposed to marked seasonal changes in the

thermal environment . This was reflected on the thermal responses of the chicks. The results indicate that (T_r) was higher in summer compared to the value measured in winter (Table 1 and Fig. 1). This is attributed to the high environmental temperature measured during summer which reduced the rate of sensible heat loss due to decrease in the thermal gradient. High environmental thermal load was associated with an increase in (T_r) in broiler chicks [12, 13]. Marked seasonal changes in (T_r) of White Leghorn and Fayoumi layers were reported under tropical conditions in Sudan [14].

(T_r) was significantly decreased in the treated group irrespective of the season (Fig. 1). This is attributed to the drug induced thyroid hypofunction which led to a reduction in metabolic heat production in the chicks. It has been reported [15] that the antithyroid drug propylthiouracil (PTU) caused a significant decrease in metabolic heat production with consequent lowering in rectal temperature of White Leghorn chicks. A decrease in (T_r) in mature Bovan chickens treated with (PTU) tropical during topical summer conditions was observed [16]. The more pronounced lowering in (T_r) in the treated group on day 21 during winter (Fig. 1) could be related to combined effects of thyroid hypofunction and enhancement of heat loss due to the increase in thermal gradient during winter. Therefore, the antithyroid drugs may have marked influence on the thermal status of chicks during winter conditions.

The decrease in food intake obtained during summer (Fig. 2) could be attributed to high ambient temperature. Thermal load is usually associated with a reduction in food intake in chickens [17, 18]. Supplementation of the antithyroid drug carbimazole was associated with a significant reduction in food intake. This could be related to the induced thyroid hypofunction and decrease in the level of circulating thyroid hormones. A positive correlation has been reported between the level of thyroid hormones, food intake and growth in chickens [19, 8]. The decrease in food intake was reflected on the observed reduction in body weight (Fig. 3).

The progressive decrease in the plasma glucose concentration during the experimental period (Fig. 4) could be related to the energy needs for the physiological processes involved in growth [20]. The results also showed that the plasma glucose concentration was lower during summer in both groups. This could be attributed to the reported reduction in food intake (Fig. 2). Also it could be related to increase in the rate of water consumption accompanied by haemodilution in response to thermal stress. The hypoglycaemia observed in chicks exposed to the antithyroid drug could be related to the lack of thyroid hormones which are known to increase the plasma glucose level by increasing the number of α-adrenergic receptors. Thyroid hormones also increase the rate of absorption of carbohydrates from gastrointestinal tract [21]. Dietary supplementation of the antithyroid drug (PTU) was associated with a decrease in hepatic glucose-6-phosphate and increase in insulin level [22, 23].

The high initial mean values of serum cholesterol concentration in the treated group (At 2 weeks of age) during winter followed by a progressive decrease could be attributed to increase in the utilization of the residual yolk as a source of energy. Similar results have reported in broilers in the 2nd week of life [24]. The significant decrease in the serum cholesterol concentration during summer in both the control and the treated chicks could be related to haemodilution. Thermally induced decrease in serum cholesterol level has been reported previously in chicks by many workers [25, 26]. The rise in serum cholesterol concentration measured in hypothyroid chicks could be attributed to the effect of the antithyroid drug on cholesterol metabolism by decreasing low density lipoprotein (LDL) receptors in the liver resulting in decreased hepatic removal of cholesterol form the circulation. Similar results have been reported in broiler chicks treated by PTU [22, 27].

CONCLUSION

Thermoregulation, body weight, food intake and certain blood metabolites of broilers were influenced by seasonal change in tropical thermal environment. The responses were modified by hypothyroidism induced by carbimazole.

REFERENCES

1. Yahav, S. and D.V. Arneja, 1995. Effect of induced hyperthermic conditions on weight of organs in White Leghorn. Indian Journal of Veterinary Sci., 72: 1040-1044.
2. Freeman, B.M., 1978. Metabolic response of the neonatal fowl (*Gallus domesticus*) to short -term heat stress. J. Thermal Biology, 3: 49-50.
3. Freeman, B.M., 1970. Thermoregulatory mechanisms of the neonate fowl. Comparative Biochemistry and Physiology, 33: 219-230.
4. Bogin, E., Y. Avidar, V. Pech-Waffenschmidt, Y. Doron, B.A. Israeli and E. Kevkhayer, 1996. The relationship between heat stress, survivability and blood composition of the domestic chicken. European Journal of Clinical Chemistry and Clinical Biochemistry, 34: 463-479.

5. May, J.D. and F.N. Reece, 1986. Relationship of photoperiod and feed intake to thyroid hormone concentration. Poultry Sci., 65: 801-806.
6. Buys, N., C.W. Scheele, C. Kwakernaak and E. Decuypere, 1999. Performance and physiological variables in broiler chicken line differing in susceptibility to the ascites syndrome. 2-Effect of ambient temperature on partial efficiencies of protein and fat retention and plasma hormone concentration. British Poultry Sci., 40: 140-144.
7. Iqbal, A., E. Decuypere, A. Abd Elazim and E.R. Kuhn, 1990. Pre- and post-hatch high temperature exposure affects the thyroid hormones and corticosterone response to acute heat stress in growing fowl (*Gallus domesticus*). Journal of Thermal Biology, 15: 149-153.
8. Yahav, S., A. Strachnow, T. Plavnik and S. Hurwitz, 1996. Effects of diurnally cyclic versus constant temperature on chicken growth and feed intake. British Poultry Sci., 37(1): 43-57.
9. Elkhair, M. Nawal and A.M. Abdelatif, 2002. Effect of dietary supplementation level of carbimazole on physiological responses of male Bovan chicks during summer conditions. Sudan Journal of Veterinary Science and Animal Husbandry, 41(1,2): 108-121.
10. Kelly, W.R., 1984. The blood and blood forming organs. In: Veterinary Clinical Diagnosis, Bailliere Tindall, London, pp: 312-33.
11. SAS, 1988. SAS/STAT User's Guide, Release 6.03 Edition, Cary, NC: SAS Institute, Inc., pp: 1028.
12. Cooper, M.A. and K.W. Washburn, 1998. The relationships of body temperature to weight gain, feed consumption and feed utilization in broilers under heat stress. Poultry Sci., 77(2): 237-242.
13. Altan, O., A. Altan, I. Oguz, A. Pabuccoglu and S. Konyalioglu, 2000. Effects of heat stress on growth, some blood variables and lipid oxidation in broilers exposed to high temperature at an early age. British Poultry Sci., 41(4): 489-493.
14. Hamza, K.M., 1989. Responses of Laying Hens to Environmental Factors, Food Intake and Water Restrictions. Ph.D. Thesis. University of Khartoum.
15. Chiasson, R.B. and W.L. Combest, 1979. The effect of propylthiouracil and temperature on avian thyroid activity. Life Sci., 25(18): 1551-1555.
16. Abdoun, K.A., 1994. Physiological and Biochemical Responses to Hypothyroidism in Bovan Laying Hens Under Summer Conditions. M.V.Sc. Thesis, University of Khartoum.
17. Settar, P., S. Yalcin, L. Turkmut, S. Ozkan and A. Cahanar, 1999. Season by genotype interaction related to broiler growth rate and heat tolerance. Poultry Sci., 78(10): 1353-1358.
18. Veldkamp, T., R.R. Kwakkel, P.R. Ferket, P.C. Simons, J.P. Noordhuizen and A. Pijpers, 2000. Effect of ambient temperature, ariginine-to-lysine ratio and electrolyte balance on performance, carcass and blood parameters in commercial male turkeys. Poultry Sci., 79(11): 1608-1616.
19. Klandorf, H. and S. Harvey, 1985. Food intake regulation of circulating thyroid hormones in domestic fowl. General and Comparative Endocrinology, 60: 162-170.
20. Goodridge, A.G., 1968. Metabolism of glucose-U-14C *in vitro* in adipose tissue from embryonic and growing chicks. American Journal of Physiology, 214: 897-901.
21. Ganong, W.F., 2003. The thyroid gland. In: Review of Medical Physiology, 21th Edition,Lange Medical Books, McGraw-Hill. Midle East Edition, pp: 320-335.
22. Raheja, K.L. and J.G. Snedecor, 1970. Comparison of subnormal multiple doses of L-thyroxine and L-triiodothyronine in propylthiouracil- fed and radiothyroidectomized chicks (*Gallus domesticus*). Comparative Biochemistry and Physiology, 37: 555-563.
23. Raheja, K.L., W.G. Linscheer, R.G. Coulson, S. Wentworth and S.E. Fincberg, 1980. Elevated insulin/glucagon ratios and decrease in cyclic AMP level accompany the glycogen and triglyceride storage syndrome in the hypothyroid chick. Hormone and Metabolism Res., 12(2): 51-55.
24. Szabo, A. and G. Milists, 2007. Clinicochemical follow-up of broiler rearing: a five week study. Acta Veterinaria Hungarica, 55(4): 451-462.
25. Ben Nathan, D., E.D. Heller and M. Perek, 1976. The effect of short heat stress upon leukocyte count, plasma corticosterone level, plasma and leukocyte ascorbic acid content. British Poultry Sci., 17(5): 481-485.
26. Puvadolpirod, S. and J.P. Thaxton, 2000. Model of physiological stress in chickens. 1. Response parameters. Poultry Sci., 79(3): 363-369.
27. Takahashi, K., Y. Akiba and M. Horiguchi, 1991. Effects of supplemental ascorbic acid on performance, organ weight and plasma cholesterol concentration in broilers treated with propylthiouracil. British Poultry Sci., 32(3): 545-554.