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Effects of Corticosterone Intake as Stress-Alternative Hormone on Broiler Chickens: Performance and Blood Parameters

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Abstract: This study was conduced to determine effects of blood corticosterone (CS) increasing on some physiological parameters and performance of boiler chickens. To avoid treatment of birds with various forms of stress with administration of CS a model was developed to study of mimicked stress in chickens. Total 180 one-day old chicks of the cobb-500 strain from male sex were placed in 12 pens. CS at 4 levels (0, 10, 20 and 30 mg L^{-1}) in drinking water was provided *ad libitum* between 1 to 49 days of age. Continuous intake of CS for 49 days caused increasing in serum glucose, cholesterol, triglycerides, high and low density lipoprotein and mortality. Final body weight, total feed intake and abdominal fat deposition were decreased, whereas feed conversion ratio was constant. The relative weights of major immunobiological organs including spleen, thymus and bursa of fabricius were decreased ($p<0.05$). Numerically, weights of selected visceral organs especially liver were elevation in all groups that received higher levels of CS. Therefore, it seems that CS intake is an alternative tool and useful test for assess the effects of physical, psychological and physiological stress in researches on broiler chickens.

Key words: Physiological parameters, glucocorticoid, mimicked stress

INTRODUCTION

Recently, animal health and welfare have received increasing attention because of ethical reason and new economic in sights (Odendaal, 1994). Approximately, forty different stressors (Puvadolpirod and Thaxton, 2000) including transportation (Mitchell and Kettlewell, 1998), over crowing (Patterson and Siegel, 1998), beak trimming and coccidiosis (McKee and Harrison, 1995) and temperature (Arjona *et al*., 1988; May and Lott, 1992; McKee *et al*., 1997; Yahav *et al*., 1997; Sandercock *et al*., 2001) and infection. Despite the large variety in stressors, overall effects are often similar (Koolhaas *et al*., 1999). This phenomenon is explained by the fact that various forms of stress are directly or indirectly translated to the body by two commonly used pathways. This two arms of stress response consist of the sympathetic-adrenalemedullary axis, resulting in the release of catecholamines and the limbic-hypothalamo-pituitary-adrenocortical axis (Koolhaas *et al*., 1999), resulting in the release of glucocorticoids that important their roles as effectors in stress is well documented (Sapolsky *et al*., 2000; Korte, 2001). Puvadolpirod and Thaxton (2000) reviewed stress in poultry and developed a model to study stress by administration of adernocorticotropic hormone (ACTH). Recently, Post *et al*. (2003) were study the short time effect of elevated plasma corticosterone (CS) concentration, on some physiological parameters in broiler chickens. They suggested that administration of CS may be a promising tool in the research of adaptation to stress by broiler chickens. Furthermore, Lin *et al*. (2007) comparison the long-or short-term dietary CS on early postmortem muscle metabolism of broiler chicken. In this study, the effects of CS as stress indicator

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on performance values, blood parameters, weights of visceral and immunobiological organs in male broilers were determined. In the other hand, an animal model was developed to study of broilers body response to agent of various stressors without excessive handling of birds in long term were examined.

MATERIALS AND METHODS

This study was conducted at Islamic Azad University, Shabestar Branch, Shabestar-Iran in summer of 2007. Total of 180 one-day old broiler chickens of the cobb-500 strain from male sex were randomly assigned in 12 pens. Each bird initially occupied 0.08 m^2 of floor space. The pens were randomized with respect to corticosterone levels. Birds were provided with continuous light. This experimental design was completely randomized design, with four treatment and three replicates. Balanced three stage diets were given *ad libitum* for all treatments at 1-49 days old. Ingredient percentage and calculated analysis starter, grower and finisher diets are provided in Table 1.

CS was diluted 1000 time in the drinking water. Concentrations of CS in drinking water were 0, 10, 20 and 30 mg L^{-1} that provided *ad libitum* for labeled treatments from 1 to 49 day of age in trough drinkers. To confidence from absorption and monitoring concentrations of blood stream CS, blood samples of 6 chickens from each group (2 chickens from per pen) were taken at 10, 20, 34 and 48 day, then CS determined by the ELISA method described by De Jong *et al*. (2001). At same times of age in fasting state, bloods samples were randomly collected from ving vein of one bird per pen and rapidly were centrifuged at 5000 rpm for 5 min and then sera by using commercial kits (Pars azmoon) in auto analyzer (ALCYON 300) were analyzed for blood parameters. Furthermore, before slathering the final body weight and after that weight of selected organs including liver, gizzard, heart, proventriculus, intestine and abdominal fat pad and immunobiological organs including thymus, spleen and bursa of fabricius were recorded individually and presented as a percentage of live weight. All obtained data from the experiment were analyzed by an analysis of variance using the General Liner Model (GLM) procedure of the Statistical analysis system and means were compared by Duncan's multiple range test.

Table 1: Composition and analysis of starter, grower and finisher diets

	Diets[1]		
Ingredients	Starter (%)	Grower (%)	Finisher (%)
Yellow corn	61.30	70.50	73.40
Soybean meal (44%CP)	20.50	28.40	19.30
Fish meal (60% CP)	7.50	7.50	2.80
Oyster shell	1.40	1.40	1.60
Mono calcium phosphate	0.40	0.35	0.70
DL-methionine	0.20	0.15	0.10
Sodium chloride	0.10	0.10	0.10
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25
Coccidiostat (Clopidol 25%)	0.10	0.10	0.10
Vitamin E	0.10	0.10	0.10
Calculated analysis			
ME (kcal kg^{-1})	3030.00	3030.00	3030.00
CP (%)	22.00	19.00	17.00
ME: CP ratio	137.00	159.00	178.00
Calcium (%)	1.16	1.12	0.95
Available phosphorus (%)	0.54	0.50	0.42
Methionine (%)	0.62	0.54	0.42
Methionine+Cystine (%)	0.93	0.76	0.64
Lysine (%)	1.32	1.09	0.87

[1]Supplemented (For each kg of the diets): Vit. A, 12000 IU; D3, 2000 IU; E, 20 mg; K3, 3 mg; B2, 7 mg; B3, 12 mg; B5, 3 mg; B12, 0.03 mg; Biotin, 0.1 mg; Choline chloride, 300 mg; and adequate anti oxidant. [2]Supplemented (For each kg of the diets): Mn, 130 mg; Fe, 70 mg; Zn, 60 mg; Cu, 12 mg; I, 1 mg; Se, 0.2 mg

RESULTS AND DISCUSSION

Serum Parameters

The blood CS level significantly increase caused by treatment with 10, 20 and 30 mg CS L^{-1} compared to control group (0 mg of CS) and each other ($p<0.05$). On the basis of mean water consumption, each bird was approximately 2, 4 or 6 mg CS kg^{-1} b.wt. per day (respectively for 10, 20 or 30 mg CS L^{-1}). With continuous of CS administration, the blood CS concentration numerically decreased (Table 2). The exogenous CS on the basis of feedback secretion system caused to decreasing of endogenous CS. whereas amount of exogenous CS that administered by drinking water in all times of experiment was constant. Present findings were in agreement with the results of studies that used osmotic pumps for a continuous infusion of CS (Post *et al*., 2003) or ACTH (Latour *et al*., 1996; Puvadolpirod and Thaxton, 2000).

The effect of drinking CS levels on serum parameters including glucose, cholesterol, Triglycerides, HDL and LDL were significantly difference ($p<0.05$) at four time stages of this experiment (Table 3). At all times of experiment, with increasing of CS levels, each five parameters had showed elevation ($p<0.05$). In broiler chickens similar to mammals, the primary effects of the glucocorticoids on carbohydrate metabolism are enhancement of gluconeogenosis and peripheral antagonism to the effects of insulin. Furthermore, chronic administration of glucocorticoid hormones leads to hyperlipemia and hypercholestrolemia and to a centripetal redistribution of body fat by LDL and HDL fractions (Melvin and William, 1996). Puvadolpirod and Thaxton (2000) and Lin *et al*. (2007) were reported that continuous delivery of adrenocorticotropic hormone (ACTH) at 8 IU kg^{-1} b.wt. per day for 7 days caused increasing in plasma CS, glucose, cholesterol, triglycerides and HDL. The result of this experiment (Table 3) indicate clearly with elevation of CS level as stress-related or alternative hormone, caused symptoms of physiological stress such as serum parameters disorders in broiler chickens.

Performance Values

Both total feed intake and final body weight decrease caused by plasma CS level elevation ($p<0.05$). This finding was in agreement with the result of other studies (Post *et al*., 2003; Dong *et al*., 2007). Proportional decreasing of these two parameters caused feed conversation ratio to be constant, although numerically with CS level increasing paucity wicked. With increasing of CS intake the abdominal fat weight significantly decreased ($p<0.05$). Although there are very large number of studies that were investigated the glucocorticoids function in mammals, the knowledge of these functions in birds is limited. The results of this study showed that CS as stress indicator caused to activation of gluconeogenosis from out hepatic proteins and mobilization of stored materials to blood stream. Therefore the satiety center in hypothalamus was activation and occasion to feed intake depression (Melvin and William, 1996). These stress effects that produce by elevation of CS levels. Leading to increasing of mortality ($p<0.05$). Virden *et al*. (2007) reported that CS administration significantly cased to mortality and depressed body weight gain, feed conversation ratio and performance from 0-40 days in commercial broilers ($p = 0.04$) (Table 4).

Table 2: Change in corticosterone concentrations of blood at four stages time of treatment

	Day of treatment (ng mL^{-1})			
CS levels (mg L^{-1})	10	20	34	48
0	8.5±0.8^{a}	8.8±0.7^{a}	8.9±0.5^{a}	9.1±0.8^{a}
10	11.3±0.8^{b}	10.8±0.7^{b}	10.7±1.1^{b}	10.1±0.9^{b}
20	17.7±1.1^{c}	16.9±0.9^{c}	16.3±1.3^{c}	15.1±1.2^{c}
30	24.8±1.3^{d}	23.7±1.2^{d}	22.1±1.8^{d}	20.9±1.7^{d}

Means±SEM within CS levels for each one of 4 stags time of treatment with no common letter(s) is differ significantly ($p<0.05$)

Table 3: Serum parameters concentrations at four times stages of corticosterone treatment

	Day of treatment (mg dL^{-1})			
CS level (mg L^{-1})	10	20	34	48
Glucose				
0	230±7[a]	268±14[a]	248±11[a]	260±12[a]
10	249±11[b]	273±5[a]	277±6[b]	291±15[b]
20	271±10[c]	290±11[b]	309±13[c]	303±15[b]
30	298±13d	311±13[c]	346±17[d]	320±11[c]
Cholesterol				
0	111±7[a]	97±3[a]	114±6[a]	122±9[a]
10	136±6[b]	111±6[b]	138±5[b]	142±7[b]
20	142±11[b]	139±10[c]	137±9[b]	162±6[c]
30	169±10[d]	167±11[d]	170±12[c]	160±7[c]
Triglycerides				
0	107±8[a]	117±10[a]	98±4[a]	111±7[a]
10	126±6[b]	120±9[a]	131±4[b]	120±6[a]
20	138±10[b]	143±11[b]	149±13[c]	141±9[b]
30	161±16[c]	167±13[c]	160±8[d]	148±5[b]
HDL				
0	41±3[a]	38±4[a]	41±2[a]	34±5[a]
10	42±3[a]	48±6[b]	47±3[a]	47±6[b]
20	47±4[b]	47±5[b]	52±7[b]	34±6[b]
30	52±6[c]	51±3[b]	53±5[b]	51±4[c]
LDL				
0	69±7[a]	73±8[a]	75±6[a]	67±4[a]
10	76±4[b]	79±7[b]	79±4[b]	77±5[b]
20	78±7[b]	88±11[c]	81±3[b]	87±7[c]
30	88±8[c]	87±9[c]	86±6[c]	89±3[c]

Means±SEM within each part of column with different letter(s) is differ significantly ($p<0.05$)

Table 4: Performance values and mortality percent at 49 day of corticosterone treatment

CS levels (mg L^{-1})	Total feed intake (g $bird^{-1}$)	Final body weight (g)	Feed conversion ratio (g g^{-1})	Abdominal fat weight (Percentage of live weight)	Mortality (%)
0	4560[a]	2121[a]	2.15	3.42[a]	2.2[a]
10	4310[b]	1968[b]	2.19	2.95[b]	8.9[b]
20	4110[c]	1868[c]	2.20	2.22[c]	13.3[c]
30	3790[d]	1670[d]	2.27	1.78[d]	20.0[d]

Means within CS levels for each performance values and mortality with no common letter(s) is differ significantly ($p<0.05$)

Table 5: Visceral organs weight at 49 day of corticosterone treatment

	(Percentage of live weight)				
CS levels (mg L^{-1})	Liver	Gizzard	Heart	Proventriculus	Intestine
0	1.61±0.08	1.80±0.06	0.45±0.02	0.37±0.01	3.80±1.02
10	1.69±0.06	1.81±0.05	0.46±0.02	0.39±0.02	4.00±1.06
20	1.76±0.03	1.93±0.04	0.45±0.03	0.40±0.02	4.10±0.05
30	1.80±0.05	1.91±0.08	0.47±0.04	0.41±0.02	4.60±1.10

Visceral and Immune Organs Weight

These results showed that CS intake elevation had no significantly effects on visceral organs weight. Although, numerically with CS intake elevation the relative weight of visceral organs, especially liver, probably due to protein synthesis by CS in liver, had showed increasing (Table 5). Dong *et al*. (2007) were reported that the breast and thigh masses (% body mass) were significantly suppressed by CS treatments, while the abdominal fat liver masses (%) were obviously increased. Also, Virden *et al*. (2007) had same opportunity. The relative weight of each three immune organs as key indicators of stress in poultry with increasing of CS levels had showed decreased ($p<0.05$) (Table 6). Post *et al*. (2003) reported that retardation in body and spleen weight, one of the first

Table 6: Immune organs weight at 49 day of corticosterone treatment

	Percentage of live weight		
CS levels (mg L^{-1})	Spleen	Thymus	Bursa of fabricius
0	1.59±0.09[a]	0.64±0.04[a]	1.11±0.08[a]
10	1.40±0.07[b]	0.51±0.03[b]	0.86±0.07[b]
20	1.23±0.08[c]	0.43±0.03[c]	0.76±0.06[b]
30	1.12±0.06[d]	0.31±0.02[d]	0.50±0.04[c]

Means±SEM within CS levels for each one of immune organs with no common letter is differ significantly ($p<0.05$)

recognized effects of stress, was observed following oral CS treatment. Furthermore, compared to body weight, the effect of CS spleen weight was stronger.

CONCLUSION

In broiler chickens, elevation of plasma CS concentration as stress-alternative hormone, caused to depressing of final body weight, total feed intake and abdominal fat deposition. Furthermore, the visceral organs weights were decreasing. The mobilization of deposed nutrient materials to blood stream leads to elevation of blood parameters. Therefore, CS administration via drinking water provides a useful model to study the effects of stress imposed through elevated circulating CS concentration. In summary, continuous intake of CS caused marked changes in most parameters measured. These, measurement of parameters are useful in monitoring a bird to stressful situations and compensatory to stress situation and compensatory mechanism to regulate metabolic changes.

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