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Effects of Dexamethasone on Physiological Changes and Productive Performance in Broilers

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Abstract: The objective of the study reported here was to evaluate the effects of dexamethasone on physiological changes and productive performances in broilers. Broilers were divided into seven groups and received dexamethasone at 0 (control group), 1, 2, 3, 4, 5 and 6 mg kg^{-1} in their diets. Percentage of heterophils, lymphocytes, heteropil/lymphocyte ratio, hemoglobin concentration, packed cell volume, total white blood cell count, body temperature, respiratory rate and productive performances (feed intake, average daily gain, feed conversion rate and body weight) of broilers were investigated on days 1, 7, 14 and 21 of the experimental period. The results revealed the following information: Heterophil, heterophil/lymphocyte ratio, total white blood cell count, body temperature, respiratory rate, packed cell volume and feed intake of broilers increased ($p<0.05$). On the other hand, lymphocyte, hemoglobin, average daily gain and body weight of broiler decreased ($p<0.05$). The results of this study indicated that synthetic glucocorticoid, dexamethasone had many effects on broilers like internal glucocorticoid. Side effects of dexamethasone to broilers were increased body temperature and respiratory rate and reduced growth rate even if feed intake of those chickens increased.

Key words: Dexamethasone, glucocorticoid, leucocytes, productive performance, broilers

INTRODUCTION

Glucocorticoids effects bring about major physiological changes of the stress response, these include: mobilization of stored energy, inhibition of subsequent energy storage, decreased feeding and appetite (Sapolsky *et al*., 2000), leucocyte changes (Schuld *et al*., 2001; Anderson *et al*., 1999; Flaming *et al*., 1994; Lo *et al*., 2005), increased body temperature (Birrenkott and Wiggins, 1984) and respiratory rate (Kopelman *et al*., 1999). Dexamethasone is a synthetic glucocorticoid used in both humans and animals. In patients who received a single oral dose of dexamethasone, Schuld *et al*. (2001) found that dexamethasone caused an increase in granulocyte counts, paralleled by decreased lymphocyte and monocyte counts. In rats, synthetic corticosterone caused reduction in lymphocytes and an increase in neutrophil numbers (Dhabhar *et al*., 2001). In cattle, dexamethasone induced leukocytosis (neutrophilia, eosinopenia, lymphopenia, monocytosis) and an increased neutrophil/lymphocyte ratio (Anderson *et al*., 1999; Oldham and Howard, 1992). In pigs, dexamethasone treatment caused neutrophilia and lymphopenia (Flaming *et al*., 1994). This was in accordance with the report of Lo *et al*. (2005), who found that short and long-term dexmethasone treatment caused mononuclear cell decrease. All of the above documents show the effects of dexamethasone on physiological changes, leucocytes parameters and metabolisms in both humans and animals. However, information on the effects of dexamethasone in chickens was little known. Therefore, the objective of this study was to determine the effects of dexamethasone on physiological changes, productive performances and the patterns of these parameters in broilers.

MATERIALS AND METHODS

Animals

One hundred and forty seven broilers from a commercial flock, 1 day of age, were brooded for 20 days at the experimental laboratory unit of the Faculty of Technology, Mahasakham University, Maha Sarakham Province 44000, Thailand. This experiment was performed during January-March, 2006.

Experimental Design

Completely randomized design was the design of the experiment. On day 21 of the experimental period, broilers were divided into seven groups and received dexamethasone at 0 (control group), 1, 2, 3, 4, 5 and 6 mg kg^{-1} in their diets. There were 3 replications/treatment and 7 broilers per experimental unit. Experiments began after a 7 day adaptation period. Continuous light and water were provided *ad libitum* throughout the experiment.

Sampling

On day 1 (before adding dexamethasone to their diets), 7, 14 and 21 of the experimental period, a blood sample (via wing vein: 2.0 mL) from five birds per treatment was collected and transferred to tubes containing EDTA as an anticoagulant. Blood films were made, air dried then stained with Giemsa- Wright's stain. Differential white blood cell counts were performed using the standard avian guidelines of Ritchie *et al*. (1994) and Heterophil/lymphocyte ratios were calculated. Total white blood cell counts were determined by the manual method using a hemocytometer (Campbell, 1995). The packed cell volume was investigated using the standard manual technique using microhematocrit capillary tubes and centrifuging at 2500 rpm for 5 min. Hemoglobin concentration was measured using the cyanmethemoglobin method (Ritchie *et al*., 1994). Feed intake and body weight gain were recorded and then feed conversion rates were calculated. The body temperature and respiratory rate of broilers were determined by using the method described by Boulahson *et al*. (1995) and direct counting of respiration (breath/minute), respectively.

Statistical Analysis

Percentage of heterophils, lymphocytes, heteropil/lymphocyte ratio, hemoglobin concentration, packed cell volume, total white blood cell count, body temperature and respiratory rate, productive performances i.e., feed intake, average daily gain, feed conversion rate and body weight of the broilers were analyzed by using the repeated measurement procedure of the Statistical Analysis System (SAS, 1990). Differences among means were identified by Duncans multiple range tests (Duncan, 1955). The level of significance was determined at $p<0.05$.

RESULTS AND DISCUSSION

The effects of dexamethasone on the physiological parameters and productive performance are presented in Table 1. The pattern of physiological parameters after receiving dexamethasone on day 1 and discontinuing on day 21 of the experimental period are shown in Table 2.

Jain (1993) reported that the heterophilia of the chickens was similar to the neutrophilia of mammals. He explained that glucocorticoid caused neutrophilia primarily by inducing the increased release of neutrophils from the bone marrow reserve through the circulation. In this current study, heterophils of the broilers that received dexamethasone at 1, 2, 3, 4 and 6 mg kg^{-1} were significantly higher than the control group. After the broilers received dexamethasone for 7 days, the heterophil on day 7 was significantly higher than that of day 1 ($p<0.05$) and then decreased to a normal range on day 14 and 21 of the experimental period. This pattern was similar with reports of Dhabhar *et al*. (2001),

Table 1: Effects of dexamethasone on physiological parameters and productive performance of broilers

Parameters	Dexamethasone concentration (mg kg^{-1}) 0	1	2	3	4	5	6	SEM
Physiological parameters								
Het. (%)	18.71d	31.98a	28.88ab	25.03bc	23.74c	22.99cd	27.19abc	1.54
Lym. (%)	65.49	58.04	58.86	61.86	63.51	62.94	58.33	2.08
HL ratio	0.31d	0.66a	0.60ab	0.41bcd	0.38cd	0.39cd	0.57abc	0.06
Hb (g dL^{-1})	6.63c	7.20ab	7.36a	7.44a	6.99abc	7.11ab	6.84bc	0.14
PCV (%)	36.92b	37.85b	40.97a	37.89b	38.77ab	38.66ab	35.74b	0.91
WBC ($x10^4$cell μL^{-1})	1.07	1.16	1.25	1.12	1.30	1.30	1.13	0.08
BT(°C)	41.16b	41.02b	41.04b	41.12b	41.07b	41.05b	42.48a	0.05
RR (b m^{-1})	23.42b	24.17b	24.83b	24.83b	24.27b	25.23b	128.69a	1.60
Productive performances								
FI (g day^{-1})	116.12a	113.11a	113.54a	113.20a	112.49a	111.84a	88.16b	2.94
ADG (g day^{-1})	45.11a	35.88ab	23.20cd	19.34cd	18.68cd	15.78d	26.62bc	2.67
FCR	2.73	3.62	5.23	44.32	8.50	19.65	4.19	8.06
BW (g)	1444a	1253b	1183cd	1136de	1096ef	1067f	1236bc	18.36

[a,b,c,d,e and f] means within row, mean with no common superscript differ significantly ($p<0.05$), SEM = Standard error of the mean; Het. = Heterophil; Lym. = Lymphocyte; BT = Body temperature; RR = Respiratory rate; HL ratio = Heterophil/lymphocyte ratio; Hb = Hemoglobin concentration; PCV = Packed cell volume; WBC = Total white blood cell count; BT = Body temperature; RR = Respiratory rate; FI = Feed intake; ADG = Average daily gain; FCR = Feed conversion rate; BW = Body weight

Table 2: Pattern of physiological parameter changes of broilers were received dexamethasone for 21 days

Parameters	Day 1	Day 7	Day 14	Day 21	SEM[1]
Het. (%)	20.52b	37.37a	22.35b	21.77b	1.16
Lym. (%)	66.59a	48.54c	62.89b	67.14a	1.04
HL ratio	0.32b	0.87a	0.38b	0.31b	0.02
Hb (g dL^{-1})	8.03a	6.62c	6.23d	7.45b	0.11
PCV (%)	39.43a	37.89b	40.56a	34.57c	0.43
WBC ($x10^4$cell μL^{-1})	0.86b	1.40a	1.24a	1.26a	0.18

[a,b and c] means within row, mean with no common superscript differ significantly ($p<0.05$), SEM = Standard error of the mean; Het. = Heterophil; Lym. = Lymphocyte; HL ratio = Heterophil/lymphocyte ratio; Hb = Hemoglobin concentration; PCV = Packed Cell Volume; WBC = Total White Blood Cell Count

Anderson *et al*. (1999) and Flaming *et al*. (1994). They found that after rats, cows and pigs were administrated dexamethasone, the neutrophils increased.

Dhabhar *et al*. (2001), Anderson *et al*. (1999) and Flaming *et al*. (1994) found that when rats and cows were injected with dexamethasone, their lymphocytes decreased; however, the current study found that when broilers were fed dexamethosone in their diets the level of lymphocytes were not significantly different ($p>0.05$). On days 7 and 14, the lymphocyte of broilers was significantly lower than on days 1 and 21 of the experimental period ($p<0.05$). Jain (1993), explaining this phenomenon, stated that dexamethasone synthetic glucocorticoid induced lymphopenia is attributed to lympholysis in blood, DNA damage, lymphoid tissue atrophy and increased shift of lymphocytes from the blood to other body compartments, therefore lymphocytes in blood circulation decreased.

The heterophil/lymphocyte ratio of broiler, after receiving dexamethasone at 1, 2 and 6 mg kg^{-1}, was significantly increased ($p<0.05$). The heterophil/lymphocyte ratio of broilers on day 7 was significantly higher than on day 1, 14 and 21 of the experimental period ($p<0.05$). This was in accord with the report of Anderson *et al*. (1999), Puvadolpirod and Thaxton (2002) and Gross and Siegel (1983). They administered dexamethasone to cattle and broilers. Glucocorticoid induced an increased neutrophil, lymphocyte and heterophil/lymphocyte ratio. Jain (1993) explained that glucocorticoid, which is released in large amounts, when animals are under stress, causes neutrophilia or heterophilia primarily by inducing the increased release of neutrophils or heterophils from the bone marrow through the circulation. Jain also explained that glucocorticoid induced lymphopenia. These explanations show that the neutrophil or heterophil/lymphocyte ratio in blood circulation increases.

The hemoglobin of broilers receiving dexamethasone at 1, 2, 3 and 5 mg kg^{-1} was significantly higher than that of the control group, while the hemoglobin of the broilers that received dexamethasone at 4 and 6 mg kg^{-1} in their diets was not significantly different ($p>0.05$). The hemoglobin of broilers was significantly decreased from day 1 to day 7 and on day 14 and then significantly increased on day 21 ($p<0.05$), respectively. The packed cell volume of broilers that received dexamethasone at 2 mg kg^{-1} in their diet was significantly higher than that of broilers fed dexamethasone at 0, 1, 3, 4, 5 and 6 mg kg^{-1} in their diets ($p<0.05$). Packed cell volume of broilers receiving dexamethasone on days 7 and 21 was significantly higher than on days 1, 7 and 21 of the experimental period ($p<0.05$). These results were both opposite and in accord with the report of Nakagawa *et al*. (1988). That report found that while the arterial hematocrit of rats that received dexamethasone decreased, tissue vascular hematocrit increased. Moreover, Pyrrho *et al*. (2004) found that dexamethasone improved hemoglobin concentration and packed cell volume. However, the mechanism that produces these effects is unknown (Nakagawa *et al*., 1988).

The total white blood cell count of broilers that received dexamethasone at 0, 1, 2, 3, 4, 5 and 6 mg kg^{-1} in their diet was not significantly different ($p>0.05$). Whereas, the total white blood cell count of broilers on day 7, 14 and 21 was significantly higher than on day 1 of experimental period ($p<0.05$). This result is similar to that of Puvadolpirod and Thaxton (2002); they administered ACTH in broilers and found that corticosterone, internal glucocorticoid level and total white blood cell count of the chickens increased.

When broilers received dexamethasone at 6 mg kg^{-1}, their body temperature and respiratory rate were significantly higher than with other treatments ($p<0.05$). This result was similar to the report of Birrenkott and Wiggins (1984). They found that when broiler received dexamethasone their body temperature rose. Sabeur *et al*. (1993) explained that when chickens were fed dexamethasone, plasma T3 level were elevated and heat production was stimulated. An increase in the respiratory rate of the chickens administered dexamethsone in this study represents a new record. The increase was similar to birds under heat stress. This behavior helped birds to reduce body temperature through evaporative heat loss to adjust homeostasis.

The feed intake of broilers fed dexamethasone at 6 mg kg^{-1} in diet was significantly higher than that of other treatments. This result was opposite to the report of Sapolsky *et al*. (2000). His review of a research article found that dexamethasone caused a decrease in feeding and appetite. The mechanism of this effect is unknown.

The average daily weight gain of broilers receiving dexamethasone at 2, 3, 4, 5 and 6 mg kg^{-1} was significantly lower than that of the control group who received 1 mg kg^{-1} of dexamethasone in their diets ($p<0.05$). The body weight of broilers that received dexamethasone at 1, 2, 3, 4, 5 and 6 mg kg^{-1} in their diets was significantly lower than that of the control group ($p<0.05$) and body weight significantly decreased when levels of dexamethasone increased. This was in accord with the report of Sabeur *et al*. (1993) that found that when chickens received dexamethasone, it caused muscular dystrophy and reduced growth. He explained that dexamethasone increases plasma T3 levels and metabolism of protein in muscle. The feed conversion rate of broilers in each treatment was not significantly different ($p<0.05$).

CONCLUSION

When broilers received dexamethasone and were then investigated for physiological changes and productive performance for 21 days, their heterophil, heterophil/lymphocyte ratio, total white blood cell count, body temperature, respiratory rate, PCV, hemoglobin and feed intake were increased. On the other hand, lymphocyte, average daily gain and body weight were decreased. The results of this study indicate that dexamethasone and glucocortocoid had many similar effects on broilers; however, dexamthasone had a higher number of effects, some of which were negative. Finally, the side effects of dexamethasone to broilers were increased body temperature and respiratory rate, decreased average daily gain and body weight even if feed intake rose.

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