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In the name of Allah

بنام خدا

NOTE

THE USE OF COTTON SEED MEAL IN BROILERS DIET[1]

استفاده از کنجاله پنبه دانه در جیره جوجه های گوشتی

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ABSTRACT

Two experiments were carried out to determine the maximum level of free gossypol which could be tolerated by broiler chicks. Also the possibility of inactivating gossypol by iron sulfate was investigated.

In the first experiment, chicks were fed diets containing different levels of free gossypol and iron sulfate for a period of 17 days. In the second experiment, chicks were fed with two levels of gossypol (zero and 980 ppm) and four levels of iron (1000, 1500, 2000, and 3000 ppm).

The data showed that growing chicks can tolerate up to 590 ppm free gossypol without any significant adverse effects on body weight gain, feed consumption, and feed conversion. Ferrous sulfate was only partially effective in alleviating the adverse effects of high levels of free gossypol on performance of growing chicks.

خلاصه

دوآزمایش مختلف بمنظورتعیین حداکثر میزان گوسیپول آزادقابل تحمل در جوجه های گوشتی وهمچنین امکان کاهش اثرات سوء آن بوسیله مصرف سولفات آهن انجام گرفت. درآزمایش اول جوجه ها با جیره های حاوی مقادیرمختلف گوسیپول وسولفات آهن برای مدت ۱۷ روزتغذیه شدند. درآزمایش دوم، جیره ها با دومیزان گوسیپول (صفرو ۹۸۰ قسمت درمیلیون) وچهارمقدار آهن (۱۰۰۰، ۱۵۰۰، ۲۰۰۰ و ۳۰۰۰ قسمت درمیلیون) مورداستفاده قرارگرفتند.

نتایج حاصله نشان دادکه جوجه های گوشتی میتوانندتا ۵۹۰ قسمت در میلیون گوسیپول آزاد رابدون داشتن اثرسوء قابل ملاحظه بررشد، مصرف خوراک وراندمان تبدیل غذا تحمل کنند. سولفات آهن تاحدودی دررفع اثرات سوء ناشی ازمصرف مقادیرزیادگوسیپول موثرواقع گردید.

INTRODUCTION

The use of cotton seed meal in poultry ration is limited due

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to its gossypol content, resulting in growth impairment and decreased feed consumption and feed conversion (1, 10).

In addition to the gossypol, lysine deficiency of cotton seed meal also restricts the use of this feed stuff in poultry rations (1). However, this deficiency can be overcome if other protein sources which are richer in lysine contents are used with cotton seed meal in the diet (9).

Cotton seed meal and soybean meal are the major plant protein sources presently used in poultry diet in Iran. Soybean meal is not produced in sufficient quantities locally, thus large amounts are imported each year to meet the demands.

Narian *et al.* (12) reported that free gossypol as low as 200 ppm depressed growth of broiler chicks. Couch *et al.* (2) found that amounts of gossypol ranging from 200 to 600 ppm in the diet had no significant adverse effect on growth. Hill and Totsuka (8) reported that 920 ppm free gossypol adversely affected body weight gain, feed consumption, and feed conversion.

One method used to inactivate free gossypol is the use of iron salts in the diet. Iron reacts with free gossypol in the digestive tract and reduces its availability and absorption (4, 11). Different iron compounds such as ferric chloride, ferrous sulfate, and iron oxide have been used, some of which were effective while others were not (5). Heywang (6) reported that ferrous sulfate could not completely inactivate free gossypol. Hopkins and Chilson (10) found that at high levels of free gossypol (1719 ppm), ferrous sulfate was only partially effective in alleviating the growth retardation.

This paper reports the results of experiments conducted to determine the maximum level of free gossypol which could be tolerated by growing chicks. Also the possibility of detoxification of free gossypol by iron sulfate is investigated.

MATERIALS AND METHODS

Experiment 1

The compositions of the experimental diets are shown in Table 1. Gossypol was determined by the method of Pons and Hoffpauir (13). Other characteristics of the sample are as reported previously (14). The main source of protein was soybean meal in the control diet (Treatment 1). In other treatments, soybean meal was gradually replaced with cotton seed meal in order to increase the free gossypol content of diets from zero to 980 ppm. The various dietary treatments were maintained isocaloric and isonitrogenous and supplied 23% protein and 3190 kcal/kg metabolizable energy. Due to increasing cotton seed meal, the methionine content of the diets was increased and the lysine content was decreased. Therefore, diets which contained less than minimal requirements were supplemented with these two amino acids. Iron sulfate (0.2%) was added to some treatments in order to provide 400 ppm iron.

Two hundred and fifty six unsexed one-day-old broiler chicks were selected from the flock kept at the university farm. All chicks were wing-banded, weighed individually, and randomly divided into 32 groups of 8 chicks each. Initial average body weights of chicks in all groups were almost identical. Every two groups were given one of the 16 experimental diets for a period of 17 days. Chicks were housed in electrical battery brooders and the brooders were located in a well-ventilated room. The room temperature was maintained at 25±2°C during the experimental period and light was provided continuously. The chicks were vaccinated against the New Castle disease on the 10th day of age and feed and water were provided *ad libitum*. At the end of the experimental period, weight gain, feed consumption, and feed conversion were calculated. When a chick died, its gain was included in the final calculations.

Table 1. The composition of experimental diets.

Treatments	Basal portion[†] (%)	Corn (%)	Cotton seed meal (%)	Soybean meal (%)	Corn oil (%)	Solka Floc[§] (%)	Methionine[¶] (%)	Lysine (%)	Total	Free gossypol (ppm)
T_1	8	46.00	--	40.00	6.00	-	0.083	-	100	-
T_2	8	46.33	5.85	33.33	6.50	-	0.073	-	100	140
T_3	8	45.00	11.68	26.69	7.30	1.33	0.068	0.05	100	280
T_4	8	45.00	17.52	20.00	7.70	1.78	0.060	0.09	100	520
T_5	8	43.00	23.36	13.35	8.70	3.59	0.055	0.14	100	590
T_6	8	42.00	29.20	6.69	9.40	4.71	0.049	0.23	100	700
T_7	8	42.50	35.05	-	9.60	4.85	0.040	0.30	100	840
T_8	8	14.50	40.00	-	18.36	19.14	0.054	0.36	100	980
T_9	As T_1 plus 400 ppm iron from ferrous sulfate									
T_{10}	" T_2	"	"	"	"	"	"			
T_{11}	" T_3	"	"	"	"	"	"			
T_{12}	" T_4	"	"	"	"	"	"			
T_{13}	" T_5	"	"	"	"	"	"			
T_{14}	" T_6	"	"	"	"	"	"			
T_{15}	" T_7	"	"	"	"	"	"			
T_{16}	" T_8	"	"	"	"	"	"			

[†]Basal portion consists of the following: Fish meal, 2 parts; bone meal, 3 parts; dehydrated alfalfa, 1.5 parts; salt, 0.5 part; and Fermavit, 1 part. Fermavit is used as a source of vitamins and minerals.
[§]Used to give bulk to diets.
[¶]Methionine and lysine were added at top of the diets.

Experiment 2

In this experiment, the chicks were fed the control diet and diet 8 (Table 1) which contained 980 ppm free gossypol. Ferrous sulfate was used at levels 0.5, 0.75, 1.0, and 1.5 percents of the diets to provide 1000, 1500, 2000, and 3000 ppm iron.

Two hundred and forty unsexed one-day-old broiler chicks were selected. All chicks were weighed individually and divided into 30 groups of 8 chicks each in such a way that the distribution of weight and the average body weights of all groups were almost identical. Every three groups were given one of the experimental diets for a period of 17 days. Other experimental conditions were similar to those of experiment 1. At the end of the experimental period, weight gain, feed consumption, and feed conversion were determined.

The data were statistically analyzed (15) and the means were compared using Duncan's new multiple range test (3).

RESULTS AND DISCUSSION

Experiment 1

Chicks could tolerate up to 590 ppm free gossypol without any significant adverse effects on their weight gain (Table 2). Body weight gains were decreased significantly ($P < 0.05$) at the levels of 700, 840, and 980 ppm free gossypol in a dose-dependent manner. Free gossypol up to 700 ppm did not affect the feed consumption, but beyond that, the feed consumption was decreased significantly ($P < 0.05$). Feed conversion increased with increasing free gossypol levels from 700 to 980 ppm as compared with the control ($P < 0.05$).

Iron sulfate was not effective in overcoming the adverse effects of the free gossypol in the diet. The adverse effects of high levels of free gossypol on weight gain

Table 2. Body weight gain, feed consumption, and feed conversion of chicks fed different levels of free gossypol and iron salt (Experiment 1).

Treatments	Free gossypol in diet (ppm)	Iron† (ppm)	Weight gain (g)	Feed consumption (g/bird/day)	Feed conversion (g feed/g gain)
1	-	-	203a*	14.2abc	1.12 l
2	140	-	187abc	15.4ab	1.32h-l
3	280	-	197ab	16.3a	1.31h-l
4	420	-	184abc	15.2ab	1.33h-l
5	590	-	193abc	15.2ab	1.34h-l
6	700	-	168cd	14.7abc	1.56c-g
7	840	-	143def	11.3d	1.61b-e
8	980	-	124efg	10.7d	1.60b-f
9	-	400	204a	15.2ab	1.25jkl
10	140	400	182abc	16.5a	1.45e-j
11	280	400	171bcd	15.2ab	1.48d-i
12	420	400	194abc	14.9ab	1.38c-h
13	590	400	174bcd	13.7abcd	1.52c-h
14	700	400	150de	13.7abcd	1.61b-e
15	840	400	120g	12.7bcd	1.80ab
16	980	400	112g	13.0bcd	1.85a
S.E.			6.70	0.09	0.03

†Iron is supplied by ferrous sulfate ($FeSO_4$, $7H_2O$).

*Means followed by the same letter in each column are not significantly different ($P > 0.05$).

and feed conversion were accentuated in the presence of supplementary iron.

The results of this experiment support the findings of Couch *et al.* (2) and Hill and Totsuka (8) who concluded that free gossypol up to 600 ppm was safe to broilers and did not have any significant adverse effects on the body weight gain, feed consumption, and feed conversion. However, they do not agree with the findings of Heywang and Bird (7) who reported that the free gossypol as low as 240 ppm reduced growth in broilers.

Experiment 2

The results of this experiment (Table 3) support the findings of experiment 1, concerning the adverse effects of high levels of free gossypol on the weight gain, feed consumption, and feed conversion of the growing chicks.

Ferrous sulfate at the levels used was not completely effective in alleviating the adverse effects of the free gossypol on body weight gain. In most cases, iron sulfate partially alleviated the adverse effects of the free gossypol on the feed consumption and feed conversion.

The results are in agreement with the findings of Heywang (6) and Hopkins and Chilson (10) who reported that ferrous sulfate did not reduce the adverse effects of the free gossypol and that it was partially effective only at higher levels of free gossypol.

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Table 3. Body weight gain, feed consumption, and feed conversion of chicks fed different levels of iron at zero and 980 ppm free gossypol (Experiment 2).

Treatments	Free gossypol in diet (ppm)	Iron (ppm)	Weight gain (g)	Feed consumption (g/bird/day)	Feed conversion (g feed/g gain)
1	-	-	194ab*	17.8cd	1.14b
2	980	-	150efg	15.7ef	1.44a
3	-	1000	200a	19.0a	1.17b
4	-	1500	182abcd	17.8cd	1.17b
5	-	2000	194ab	18.3ab	1.14b
6	-	3000	194ab	18.0cdef	1.16b
7	980	1000	160cdef	16.8cde	1.30ab
8	980	1500	154defg	16.7cdef	1.32ab
9	980	2000	155defg	16.9cde	1.32ab
10	980	3000	146fg	16.2def	1.33ab
S.E.			6.86	0.27	0.04

†Iron is supplied by ferrous sulfate ($FeSO_4$, $7H_2O$).

*Means followed by the same letter in each column are not significantly different ($P > 0.05$).

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