Effects of Replacement of Soybean Meal by Cottonseed Meal on Laying Performance and Haemoglobin Levels in Practical Diets for Breeder Japanese Quail, *Coturnix coturnix japonica**

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ABSTRACT : A 16 week feeding trial was conducted to evaluate the effects of replacement of soybean meal (SM) by extracted cottonseed meal (CSM) on laying performance and haemoglobin levels in practical diets for breeder Japanese quail (*Coturnix coturnix japonica*). One hundred ninety two quails (6 weeks old) were divided randomly into eight groups. The diets were isocaloric containing 2,900 kcal/kg of ME and isonitrogenous (% 20 crude protein) as fed basis. SM was replaced by 0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0 and 17.5% of CSM, respectively. Average egg production (quail day, %; quail house, %), egg weight (g), daily feed intake (g/bird), feed efficiency ratio (g feed/g egg) data indicated no significant differences among the treatments; while, blood haemoglobin levels (% g Hb) of 7th (15.0% CSM) and 8th (17.5% CSM) group were lower than the control (0% CSM) diet ($p<0.05$). This experiment indicated that 17.5% CSM could replace SM (providing 44% of SM protein) in practical diets of breeder Japanese quails without any significant impairment on laying performance. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 7 : 980-983)***

Key Words : Cottonseed Meal, Japanese Quail, Egg Production, Blood Haemoglobin Levels

INTRODUCTION

Cottonseed (CS) production has increased, leading to increased availability of cottonseed meal (CSM) as an inexpensive protein source in animal diets. CSM, a by-product of the cotton oil and fibre industry, is fed to animal as a valuable source of protein (Pattanaik et al., 2003). However, its use in poultry diets has been restricted due to fear of gossypol toxicity and concerns about protein quality and fiber content (Phelps, 1966). CSM contains also 2 cyclopropenoid fatty acids (CPFA), malvalic acid and sterculic acid. Gossypol adversely affects liver and kidney function, erythrocyte oxygen-carrying or -releasing capacity, respiration rate, feed intake, production and reproductive capacity (Calhoun et. al., 1990). It is a naturally occurring polyphenolic dialdehyde [1, 1', 6, 6' 7, 7'-hexahydroxy-5, 5'-diisopropyl-3, 3' dimethyl (2, 2') binophtalenyl-(8, 8') dicarbaldehyde], present in cotton plants, *Gossypium sp*., especially in its pigment glands. Gossypol also prevents iron absorption and decreases its tissue content, thus, reducing haemoglobin levels. Total gossypol is defined as the sum of bound and free gossypol and gossypol derivatives. Free gossypol concentration is the primar factor used to determine the inclusion level of CSM in animal feeds. There is no agreement among scientists on gossypol level impairing laying performance. This can probably be attributed to the source of the gossypol used (Waldroup and Goodner, 1973). Heywang and Bird (1954) reported that both feed consumption and egg production was adversely affected by the diets containing 160 ppm gossypol or more, while the study of Narian et al. (1957) indicated a depressed feed consumption rate at 200 ppm level and egg production ceased at 1,500 ppm Waldroup and Goodner (1970) reported depression on egg production at 400 ppm. Similarly, the overall performance of hens fed on a 75 g CSM/kg diet was not significantly different from control but a 300 g CSM/kg diet, containing 255 ppm free gossypol and giving daily intake per hen of 26.2 mg free gossypol, significantly reduced food intake and egg production (Panigrahi et al., 1989).

Introduction of new cotton varieties, new methods of oil extraction, development of new analytical methods of separation of (+) and (-) gossypol enantiomers in tissue and CS, suggest that processing conditions affect gossypol availability thus also affecting recommendations on the use of CSM in poultry diets. Similarly, it was reported that there would be differences among the meals obtained from different regions and cotton varieties in terms of both nutrient and gossypol contents (Bulgurlu and Ergul, 1970). Studies on the use of CSM and CS as cheap feeds in hens (Sterling et al., 2002), pigs (Shim et al., 2003) lambs (Nagalakshmi et al., 2002; Nagalakshmi et al., 2003), cattles (Burns et al., 1990), water buffaloes (Mirza et al., 2004), rabbits (Bhatt and Sharma, 2001) and fish (Lee et al., 2002) have been accelerated.

The objective of this study was to determine effects of replacement of SM by CSM on egg production (quail

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Table 1. Ingredients and chemical composition of the diets fed to breeder Japanese quail

İngredients	1	2	3	4	5	6	7	8
Corn	55.77	55.29	54.82	54.34	53.87	53.39	52.91	52.40
Soybean meal	34.68	32.50	30.32	28.14	25.96	23.78	21.60	19.42
Ext. Cottonseed meal	-	2.50	5.00	7.50	10.00	12.50	15.00	17.50
Vegetable oil	1.76	1.92	2.08	2.23	2.39	2.55	2.71	2.88
Dicalcium phosphate	0.54	0.51	0.49	0.47	0.45	0.42	0.40	0.38
Powder marble	6.30	6.32	6.34	6.36	6.38	6.41	6.43	6.45
Vitamin mix.[a]	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Mineral mix.[b]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Salt	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.25
DL-methionine[c]	0.11	0.11	0.11	0.14	0.11	0.11	0.11	0.11
Chemical composition								
Crude protein, %[d]	20.12	19.81	20.21	19.69	19.73	20.31	19.54	20.36
ME, kcal/kg[e]	2,900.0	2,900.0	2,900.0	2,900.0	2,900.0	2,900.0	2,900.0	2,900.0
Crude fiber, %[d]	3.20	3.41	3.62	3.83	4.04	4.24	4.45	4.66
Ether extract, %[d]	4.32	4.49	4.65	4.82	4.98	5.15	5.31	5.49
Ash, %[d]	9.50	9.55	9.61	9.66	9.72	9.77	9.83	9.88
Free gosypol, mg/kg[e]	-	12.	24	36	48	60	72	84
Calcium, %[e]	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Phosphorus (avail.), %[e]	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Methionine, %[e]	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Lysine, %[e]	1.12	1.11	1.09	1.07	1.05	1.03	1.01	1.00
Methionine+cysteine, %[e]	0.77	0.78	0.78	0.78	0.78	0.79	0.79	0.79

[a] Provides: 6,000,000 IU vitamin A, 1,320,000 IU vitamin D_3, 10,000 mg vitamin E, 2,250 mg vitamin K_3, 900 mg, B_1, 3,000 mg vitamin B_2, 1,200 mg vitamin B_6, 10 mg vitamin D_{12}, 12,000 mg niacin, 6,000 mg calciyum D pantothenate, 300 mg folic acid, 12,000 vitamin C, 120,000 mg choline chloride, 5,000 mg antioxidant, 213,188 mg calcium per kg of the mix.

[b] Provides: 80,000 mg Mn, 30,000 mg Fe, 60,000 mg Zn, 5,000 mg Cu, 500 mg Co, 2,000 mg I, 235,680 mg $CaCO_3$ per kg of the mix.

[c] 98.5% DL-methionine. [d] Determined by lab analyzes. [e] Determined by calculation.

Table 2. Chemical composition of the extracted CSM used in the experimental diets

Dry matter, %	92.79
Crude protein, %	30.56
Ether extract, %	5.8
Crude fiber, %	17.1
Ash, %	4.89
Organic matter; %	87.9
N free extracts, %	34.44
Free gossypol, ppm	480

day, %; quail house, %), egg weight (g), daily feed intake (g/bird), feed efficiency ratio (g feed/g egg) and blood haemoglobin levels (% g Hb) in practical breeder Japanese quail, C*oturnix coturnix japonica* diets.

MATERIALS AND METHODS

Eight isocaloric (2,900 kcal ME/kg) and isonitrogenous (20% crude protein) diets containing CSM at the levels of 0 (control-group 1), 2.5% (group 2), 5.0% (group 3), 7.5% (group 4), 10.0% (group 5), 12.5% (group 6), 15.0% (group 7) and 17.5% (group 8) were formulated according to National Research Council (1994) standards (Table 1). The chemical composition of CSM used in the study was given in Table 2. The CSM was analyzed for a possible aflatoxin B_1 contamination and found to be free (Howel and Taylor, 1985). The feeding trial was carried out at agriculture facility of Animal Science Department at Akdeniz University (Antalya-Turkey). One hundred ninety two 6 wk old breeder female Japanese quail (*Coturnix coturnix japonica)* (initial body weight, 181.68±0.44 g) were randomly assigned to 8 treatment groups, each consisting of 6 replicates of 4 birds. Each quails were reared in wire cages during the experimental period lasting 16 weeks. Before the trial, birds were fed the control diet for two weeks in order to adapt to the experimental conditions. During the trial, light was provided for 24 h. Birds were weighed at the beginning and at the end of the study to calculate live weight gains [LWG=final live weight, g-initial live weight, g]. Egg production was recorded daily and calculated as quail day, % (QD, %); quail house, % (QH, %). All eggs produced were weighed in each week to obtain egg weight data (EW). Daily feed intake (FI) (g/quail) and feed efficiency ratio (FER) (g feed/g egg) were determined weekly. At the end of the study, 12 birds were randomly selected from each treatment, and blood samples were taken from the *Vena jugularis* for haemoglobin analysis. Mortality was recorded daily.

Analyses of crude protein, dry matter, ash, ether extract, crude fiber and N-free extracts of each diet and CSM were determined by standard procedures of AOAC (1995). Free gossypol analysis in CSM was carried out with the method described by Turkish Standards Institution (1988). Haemoglobin levels (% g Hb) were measured by using the

Table 3. Effects of replacement of SM by CSM on laying performance and haemoglobin levels in breeder japanese quail, (*Coturnix coturnix japonica)*

	GROUPS							
	1	2	3	4	5	6	7	8
Egg production QD[a], %	63.24±2.32	62.95±2.15	61.52±3.52	64.25±2.65	61.82±2.62	61.23±2.91	59.64±2.57	59.32±2.03
Egg production QH[b], %	61.11±1.22	59.68±2.14	60.46±2.59	60.65±2.44	59.26±2.07	58.90±3.06	59.89±2.15	59.32±2.64
EW[c], g	11.46±2.86	11.39±254	11.43±2.78	11.44±2.62	11.40±2.54	11.42±2.99	11.39±2.62	11.39±2.12
FI[d], g/bird/day	24.86±0.54	24.33±0.45	25.01±0.21	24.66±0.12	24.43±0.41	25.19±0.48	24.23±0.55	24.96±0.60
FER[e], g feed/g egg	3.17±0.39	3.24±0.49	3.01±0.27	2.85±0.43	3.05±0.43	3.24±0.54	3.56±0.34	3.07±0.41
LWG[f], g	1.95±8.65	2.16±7.99	1.88±9.01	2.39±8.42	2.01±6.12	1.82±6.99	2.04±7.45	1.97±8.96
Haemoglobin, % g Hb	$12.51±0.26^{a}$	$12.09±0.11^{ab}$	$12.31±0.24^{a}$	$11.87±0.27^{abc}$	$11.54±0.15^{abc}$	$11.59±0.26^{abc}$	$11.08±0.17^{c}$	$11.21±0.30^{bc}$
Viability, %	6.25±4.44	5.43±4.56	5.01±4.63	4.98±4.01	5.12±4.95	6.02±3.96	5.89±4.53	5.12±3.67

Means having different letters within a row are significantly different ($p<0.05$).
[a] QD: Quail day, [b] QH: Quail hause, [c] EW: Egg weight, [d] FI: Feed intake, [e] FER: Feed efficiency ratio, [f] LWG: Live weight gain.

Sahli Haemometer (Marienfeld-Germany). A one-way analysis of variance (ANOVA) and Duncan's multiple range tests were used to compare treatment means and they were tested at $p\leq0.05$ level.

RESULTS AND DISCUSSIONS

The average quail day (%), quail house (%), egg production, egg weight (g/egg), daily feed intake (g/quail), feed efficiency ratio (g feed/g egg), live weight gain (g), haemoglobin level (%g Hb) and viability (%) of experimental groups were given in Table 3.

There were no significant differences among the groups fed diets containing different levels of CSM in terms of egg production as quail day (%), quail house (%) (Table 3). These results were supported by the findings of Yannakopouluis and Tserveni-Gousi (1989) and Yıldırım and Öztürk (1999). It was also reported that CSM added rations up to 10% (Waldroup and Goodner, 1973) and 30% (Panigrahi, 1989) did not affect the egg production (hen day, eggs).

It seems that CSM replacement did not affect the egg weight data. Yıldırım and Öztürk (1999) reported that the mean egg weights were between 11.92±0.19 to 11.46±0.31 when 35% CSM replaced SM in Japanese quail rations compared to the value of 12.04±0.26 in the control group. On the other hand, Yannakopouluis and Tserveni-Gousi (1989) found the mean egg weights to be between 11.6 and 11.4 with up to 100% CSM replacement.

When the average daily feed intakes and feed efficiency ratios were considered no differences among the groups have been observed. In other words, 2.08 mg of gossypol consumed daily in the % 17.5 CSM group had no negative effect on feed consumption. It has been reported that when dietary free gossypol levels were increased to 130 mg/kg feed intake was not affected. Two hundred fifty five mg per kg decreased the intake however even this level did not affect the feed efficiency ratio (Panigrahi, 1989). In another study, rate of egg production, egg weight and feed intake of laying hens were not significantly depressed at dietary free gossypol levels up to 200 ppm (Waldroup et al., 1973). The data obtained from this experiment were in agreement with the reports presented above. However, Kovan and Ergul (1979), Yannapoulis and Tserveni-Gousi (1989) indicated that as the ration CSM levels increased, feed efficiency ratio declined significantly.

It can be seen in Table 3 that there were no significant differences among the groups in the means of live weight and live weight gain data. These results supported the results reported by Panigrahi et al. (1989) and Yıldırım and Öztürk (1999). Similarly, there were no any significant differences among the viability averages of the groups calculated from daily records of death animals.

Analysis of blood haemoglobin showed that average % g Hb value for the groups fed 15% and 17.5 CSM were significantly lower than the control group. Depending on these results, it could be stated that gossypol at the levels of 72 or 84 mg/kg bound important amount of iron resulting in increased tissue losses and decreased blood haemoglobin level.

It should be taken into consideration that the reason for the differences among the results of various studies could be differences in variety of the seed utilized, differences in the region where the seed grown and differences in the production methods of the meal. However, it was reported by many previous reports that SM could be replaced by CSM at various levels.

Consequently, the present study indicated that use of extracted CSM containing 480 mg/kg free gossypol at 17.5% in breeder Japanese quail (*Coturnix coturnix japonica*) rations during laying period caused significant decrease in blood haemoglobin levels; while, it did not affect average egg production (quail day, %; quail house, %), feed intake, feed efficiency ratio and viability data (Table 3). In other words, it is possible that 44 % of the SM protein could be replaced by CSM (which is much cheaper than SM) during the laying period of breeder Japanese quails.

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